

Course Code	Course Title	L	T	P	C
BECE355L	Advanced Cloud Computing	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1.To impart knowledge on AWS cloud management tools and services for developing cost-effective and reliable cloud solutions for real-world scenarios.					
Course Outcomes					
At the end of the course, the student will be able to					
1. Comprehend the AWS cloud concepts and service models.					
2. Comprehend and differentiate between various AWS core, database services and its applications.					
3. Apply appropriate security and compliance measures for cloud applications.					
4. Design scalable, fault-tolerant and cost-effective AWS solutions using core services.					
5. Apply AWS management tools, monitoring services to automate and troubleshoot tasks.					
6. Configure and manage AWS networking and content delivery services.					
Module:1	AWS Cloud Concepts	6 hours			
Introduction to Cloud Computing, Overview of AWS Cloud, Cloud Service Models: IaaS, PaaS, SaaS, Cloud Deployment Models: Public, Private, Hybrid, AWS Global Infrastructure, AWS Shared Responsibility Model.					
Module:2	AWS Core Services	8 hours			
Amazon EC2 (Elastic Compute Cloud), Amazon S3 (Simple Storage Service), Amazon RDS (Relational Database Service), Amazon VPC (Virtual Private Cloud), Amazon SQS (Simple Queue Service), Amazon SNS (Simple Notification Service).					
Module:3	AWS Database services	6 hours			
AWS Lambda, Amazon Dynamo DB, Amazon ECS (Elastic Container Service), Amazon S3 Glacier, Amazon Kinesis, Amazon Redshift, Amazon EMR (Elastic MapReduce), AWS Disaster Recovery and Backup.					
Module:4	AWS Security and Compliance	4 hours			
AWS Identity and Access Management (IAM), AWS Shared Responsibility Model in Security, AWS Key Management Service (KMS), AWS Inspector, AWS Organizations, AWS Trusted Advisor, Compliance on AWS.					
Module:5	AWS Architectural Best Practices	6 hours			
AWS Well-Architected Framework, Design Principles for AWS Cloud Architectures, Scalability and Elasticity, High Availability and Fault Tolerance, Cost optimization and AWS pricing, Performance Efficiency.					
Module:6	AWS Operational Excellence	6 hours			

AWS Management Console, AWS CLI (Command Line Interface), AWS SDKs, AWS Cloud Formation, AWS Trusted Advisor, AWS Cloud Watch, AWS Systems Manager.			
Module:7	AWS Networking and Content Delivery		7 hours
Amazon Route 53, Amazon Cloud Front, Amazon API Gateway, AWS Direct Connect, AWS VPN (Virtual Private Network), AWS Transit Gateway.			
Module:8	Contemporary Issues		2 hours
Guest Lecture from Industry Expert			
	Total Lecture hours:		45 hours
Text Book(s)			
1.	Saurabh Shrivastava , Neelanjali Srivastav , Alberto Artasanchez, “AWS for Solutions Architects”, 2 nd edition, Packt Publishing, 2023.		
2.	Ashish Prajapati , Juan Carlos Ruiz , Marco Tamassia, “AWS Cloud Computing Concepts and Tech Analogies”, Packt Publishing, 2023.		
Reference Books			
1.	Logan Song, “The Self-Taught Cloud Computing Engineer”, Packt Publishing, 2023		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies		21-05-2024	
Approved by Academic Council		No. 77	Date 13-03-2025

Course Code	Course Title	L	T	P	C
BECE320E	Embedded C Programming	2	0	2	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To impart logical thinking and fundamental problem-solving skills via the use of a programming language. 2. To develop basic and advanced programming concepts using C and Embedded C language. 3. To interface with microcontroller using Embedded C language.					
Course Outcomes					
The student will be able to 1. Apply the C programming language for various data types and decision making applications. 2. Comprehend the derived data types, pointers and creation of functions. 3. Describe the architecture of 8051 microcontroller for programming & interfacing applications. 4. Write the embedded C code to 8051 for programming I/O ports, timers, serial communication, interrupt and interfacing external peripherals. 5. Develop microcontroller based applications.					
Module:1	Introduction to C	3 hours			
Introduction to Embedded C, difference between C and Embedded C. Introduction to C programming, comments, identifiers, variables, headers, data types, operators, order of operations, format specifies, escape sequence characters, input and output statements, programs on sequential statements.					
Module:2	Control and loop statements	4 hours			
Control statements: if, if-else, if-else ladder, elseif ladder, switch. Loops: do-while, while, for loops and nested loops. Break, continue, goto and exit statements. Programs on if, switch and loops.					
Module:3	Arrays and strings	3 hours			
Arrays: one dimensional and multi-dimensional array, programs on arrays. Strings, functions, pointers.					
Module:4	Introduction to 8051 microcontroller	6 hours			
Introduction to microcontroller, difference between microcontroller and microprocessor, 8051 : architecture, pin diagram of 8051, memory organization, special function registers, I/O pins ,timers, interrupts, serial interface, power consumption, external interface of the standard 8051.					
Module:5	8051 programming in C	4 hours			
Data types: sbit, sfr, and bit. Producing delay using loops, programming I/O ports: bit addressable and byte addressable programming, programs on sending and receiving data through I/O ports. Programs on logic operations, data conversion, data serialization with I/O ports.					
Module:6	Timer and serial port programming	4 hours			
Programs on accessing timers registers, programs on producing time delay using mode 1 and mode 2, programs on generating various clock frequencies, programming of timers 0 and 1 as counters. Serial port programming: transmitting					

and receiving data with different baud rates. Programs on timer and Serial communication interrupts.			
Module:7		Interfacing with displays and sensors	4 hours
Programming of keyboard interfacing, programming of LEDs interfacing, programming of seven segment display interfacing, interfacing circuit description and programming of 16 x 2 LCD, ADC, DAC and temperature sensor interfacing.			
Module:8		Contemporary Issues	2 hours
		Total Lecture hours:	30 hours
Text Book(s)			
1	Mike McGrath, C Programming in easy steps, 2019, 4th Edition, In Easy Steps Limited.		
2	Muhammad Ali Mazidi , Janice Gillispie Mazidi , Rolin McKinlay, 2014, The 8051 Microcontrollers & Embedded Systems , 2nd edition, Pearson.		
Reference Books			
1.	Barrett, Michael, and Ambony Massa. Programming Embedded Systems, with C and GNU Development Tools, 2020, O'Reilly Media.		
2	Herbert Schildt, C: The Complete Reference, 2017, 4th Edition, McGraw Hill Education.		
Mode of evaluation: Internal Assessment (CAT, quizzes, Digital Assignments) & Final Assessment Test (FAT)			
Lab Component :			
Indicative Experiments			
1	Programs on Sequential statements		2 hours
2	Programs on Condition and Control statements		2 hours
3	Programs on Arrays		2 hours
4	Programs on Strings & Functions		2 hours
5	Programs on I/O ports		2 hours
6	Programs on Timer/Counter		4 hours
7	Programs on serial communication		2 hours
8	Programs on Timer Interrupts		2 hours
9	Programs on Serial Communication Interrupts		2 hours
10	Programs on External interrupts		2 hours
11	Programs on interfacing Keypad and LCDs		4 hours
12	Programs on interfacing ADC, DAC and Sensors		4 hours
Total Laboratory Hours			30 hours
Mode of assessment: Continuous assessment and FAT			
Recommended by Board of Studies		07-11-2023	
Approved by Academic Council		No. 72	Date 13-12-2023

BCSE103E	Computer Programming : Java		L	T	P	C
			1	0	4	3
Pre-requisite	NIL	Syllabus version				
		1.0				
Course Objectives:						
1. To introduce the core language features of Java and understand the fundamentals of Object -Oriented programming in Java.						
2. To develop the ability of using Java to solve real world problems.						
Course Outcome:						
At the end of this course, students should be able to:						
1. Understand basic programming constructs; realize the fundamentals of Object Orientated Programming in Java; apply inheritance and interface concepts for enhancing code reusability.						
2. Realize the exception handling mechanism; process data within files and use the data structures in the collection framework for solving real world problems.						
Module:1	Java Basics		2 hours			
OOP Paradigm - Features of Java Language - JVM - Bytecode - Java program structure – Basic programming constructs - data types - variables – Java naming conventions – operators.						
Module:2	Looping Constructs and Arrays		2 hours			
Control and looping constructs - Arrays – one dimensional and multi-dimensional – enhanced for loop – Strings - Wrapper classes.						
Module:3	Classes and Objects		2 hours			
Class Fundamentals – Access and non-access specifiers - Declaring objects and assigning object reference variables – array of objects – constructors and destructors – usage of “this” and “static” keywords.						
Module:4	Inheritance and Polymorphism		3 hours			
Inheritance – types — use of “super” – final keyword - Polymorphism – Overloading and Overriding - abstract class – Interfaces.						
Module:5	Packages and Exception Handling		2 hours			
Packages: Creating and Accessing - Sub packages. Exception Handling - Types of Exception - Control Flow in Exceptions - Use of try, catch, finally, throw, throws in Exception Handling - User defined exceptions.						
Module:6	IO Streams and Files		2 hours			
Java I/O streams – FileInputStream & FileOutputStream – FileReader & FileWriter- DataInputStream & DataOutputStream – BufferedInputStream & BufferedOutputStream – PrintOutputStream - Serialization and Deserialization.						
Module:7	Collection Framework		2 hours			
Generic classes and methods - Collection framework: List and Map.						
			Total Lecture hours:		15 hours	
Text Book(s)						
1.	Y. Daniel Liang, “Introduction to Java programming” - comprehensive version-11 th Edition, Pearson publisher, 2017.					
Reference Books						
1.	Herbert Schildt , The Complete Reference -Java, Tata McGraw-Hill publisher, 10 th Edition, 2017.					
2	Cay Horstmann, ”Big Java”, 4th edition, John Wiley & Sons publisher, 5 th edition, 2015					
3	E.Balagurusamy, “Programming with Java”, Tata McGraw-Hill publishers, 6 th edition, 2019					

Mode of Evaluation: No separate evaluation for theory component.			
Indicative Experiments			
1.	Programs using sequential and branching structures.		
2.	Experiment the use of looping, arrays and strings.		
3.	Demonstrate basic Object-Oriented programming elements.		
4.	Experiment the use of inheritance, polymorphism and abstract classes.		
5.	Designing packages and demonstrate exception handling.		
6.	Demonstrate the use of IO streams, file handling and serialization.		
7.	Program to discover application of collections.		
Total Laboratory Hours			60 hours
Text Book(s)			
1.	Marc Loy, Patrick Niemeyer and Daniel Leuck, Learning Java, O'Reilly Media, Inc., 5 th Edition, 2020.		
Reference Books			
1.	Dhruti Shah, 100+ Solutions in Java: A Hands-On Introduction to Programming in Java, BPB Publications, 1 st Edition, 2020.		
Mode of assessment: Continuous assessments and FAT			
Recommended by Board of Studies		03.07.2021	
Approved by Academic Council	No. 63	Date	23.09.2021

Course Code	Course Title		L	T	P	C
BECE497J	Project-I		0	0	0	3
Pre-requisite	NIL	Syllabus version				
		1.0				
Course Objectives						
1. To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.						
Course Outcomes						
1. Demonstrate professional and ethical responsibility. 2. Evaluate evidence to determine and implement best practice. 3. Mentor and support peers to achieve excellence in practice of the discipline. 4. Work in multi-disciplinary teams and provide solutions to problems that arise in multi-disciplinary work.						
Module Content		(Project Duration: One Semester)				
Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities. Can be individual work or a group project, with a maximum of 3 students. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project. Publications in the peer reviewed journals / International Conferences will be an added advantage.						
Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews.						
Recommended by Board of Studies		12-10-2022				
Approved by Academic Council		No. 68	Date	19-12-2022		

Course code	Course Title	L	T	P	C
BBMD205L	Biomaterials	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To discuss about the basic fundamentals of biomaterials with its classification.					
2. To discover various properties of biomaterials and its significance in healthcare industry.					
3. To identify the process involved in design and development of various artificial organs and its importance.					
Course Outcome					
The student will be able to					
1. Analyze and classify the different properties and classification of biomaterials.					
2. Evaluate the design constraints of artificial organs and its outlook for organ replacement.					
3. Design and develop the need for appropriate considerations in different types of artificial organs like kidney, heart, lungs, liver and blood.					
4. Apply ethical concepts in designing the artificial organs for healthcare industry.					
5. Diagnose the need for the preparation and ability to engage in independent and life-long learning for technological updates in artificial organs.					
Module:1 Structure and properties of Materials 6 hours					
Introduction to Biomaterials Science – Properties of Materials – The nature of Matter and Materials – Bulk Properties of Materials – Surface Properties and Surface Characterization of Biomaterials – Role of Water in Biomaterials.					
Module:2 Classes of Materials used in Medicine 8 hours					
The Materials side of the biomaterials relationship – Polymers – Polyurethanes – Hydrogels – Degradable and resorbable polymers – Metals – Titanium alloys – Stainless steel – CoCr alloys – Biodegradable metals – Ceramics – Glasses and Glass ceramics.					
Module:3 Host Reaction to Biomaterials and their evaluation 5 hours					
Biological Responses to Materials – Inflammation – Wound healing – Foreign body response and alternative tissue responses – Innate and adaptive Immunity – Blood coagulation and Blood Material interactions – Tumorigenesis - Biofilms and Device related infections.					
Module:4 Characterization of Biomaterials 6 hours					
Concept and assessment of Biocompatibility – <i>In vitro</i> and <i>In vivo</i> assessment of cell and tissue compatibility – Evaluation of Blood materials interactions – Physical – chemical – mechanical characterization techniques used for biomaterials.					
Module:5 Applications of Biomaterials 6 hours					
Cardiovascular medical devices – Heart valves – Mechanical circulatory support – Stents – Grafts – Orthopedic applications – Dental applications – Ophthalmologic applications – Burn dressings and skin substitutes.					
Module:6 Artificial Cells and Extracorporeal Artificial organs 6 hours					
Basic features of artificial cells – Research into the application of artificial cells Artificial cells in Hemoperfusion – Artificial cells containing stem cells in regenerative medicine.					
Module:7 Biomaterial applications in Artificial organs 6 hours					
Repair of skeletal tissues – Joint replacement – Artificial organs – Mass transport processes in artificial organs – Artificial exchange systems.					
Module:8 Contemporary Issues 2 hours					
Total Lecture hours: 45 hours					
Text Book(s)					

1.	William Wagner, Shelly Sakiyama-Elbert, Guigen Zhang, Michael Yaszemski, Biomaterials Science - An Introduction to Materials in Medicine, 2020, 4 th edition, Elsevier Science.		
2.	Michael Lysaght, Thomas J Webster, Biomaterials for Artificial Organs, 2018, 1 st edition, Elsevier Science.		
Reference Books			
1.	Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, Biomaterials Science., 2013, 3rd edition, Academic Press, Elsevier Science.		
2.	Gerald E. Miller, Artificial Organs – Synthesis lectures on Biomedical Engineering., 2006, 1st edition, Morgan and Claypool Publishers.		
3.	Hench Larry L (Ed)., Biomaterials artificial organs and tissue engineering., 2005, 1st edition., Woodhead Publishing Limited.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BBMD203P	Medical Image Analysis Lab	0	0	2	1
Pre-requisite	BECE301L, BECE301P	Syllabus version			
		1.0			
Course Objectives					
1. To discover the principles filtering techniques in spatial domain and frequency domain forenhancement and restoration.					
2. To identify the segmentation techniques for feature extraction from images and classification.					
3. To formulate image registration techniques and virtual reality.					
Course Outcome					
1. Develop algorithms to solve the given problems.					
2. Design and Conduct experiments individually and as a team and report the outcome.					
Indicative Experiments					
1.	Read the given x-ray image using Matlab software and perform contrast enhancement and remove the noise using spatial low pass filters. Compare their performance.				6 hours
2.	Read the CT image of the given lungs image, perform intensity enhancement, and extract the nodules in the lungs using Matlab software.				6 hours
3.	Segment the white matter, gray matter and CSF from the given MRI image using Matlab software.				6 hours
4.	Process the given endoscopic images and extract the tumor detected using Matlab software.				6 hours
5.	Extract the blood vessels from the given retinal image using Matlab software.				6 hours
	Total Laboratory Hours:				30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course code	Course Title	L	T	P	C
BBMD203L	Medical Image Analysis	2	0	0	2
Pre-requisite	BECE301L, BECE301P	Syllabus version			
		1.0			
Course Objectives					

1.	Atam P Dhawan, Medical Image Analysis, 2011, 2 nd edition, Wiley, Oxford.		
2.	Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, 2018, 4th edition, Pearson Education, New York.		
Reference Books			
1.	Anil Jain K. “Fundamentals of Digital Image Processing”, 2011, 1 st edition, Prentice Hall India Learning Pvt. Ltd, Delhi.		
2.	William K Pratt, “Digital Image Processing”, 2013, 1 st edition, CRC Press, Florida.		
3.	G Dougherty, “Medical Image Processing Techniques and Applications”, 2011, Springer, ISBN: 978-1-4419-9779-1		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BBMD202P	Bio Signal Analysis Lab	0	0	2	1
Pre-requisite	BECE202L	Syllabus version			
		1.0			
Course Objectives					
1. To understand the fundamentals of biomedical signal acquisition and signal classification.					
2. To impart knowledge about physiological signal processing and analysis.					
3. To apply adaptive filtering techniques for cancelling noise and interference in the various bio-signals.					
Course Outcome					
1. Evaluate the classification of bio signals using wavelets.					
2. Demonstrate the feature reduction methods for different bio signals.					
Indicative Experiments					
1.	Acquire two ECG samples from same and two different individuals. Perform correlation between the samples. Tabulate and interpret the results.				6 hours
2.	Acquire the ECG signal and add 60 Hz sine wave to it. Plot the PSD to show the noise on the mixed signal. Design an appropriate filter to remove the noise and plot the PSD of the filtered signal to show that noise is removed. Explain the design aspect of the filter.				6 hours
3.	Acquire 4 channel simultaneously recorded EEG signals with spike and wave complexes. Cut out spike and wave complex from any one of the channel and keep it as template. Perform template matching. i) Same channel when the template is selected ii) Other channels				6 hours
4.	Process a bio-signal and extract higher order statistical feature using ICA from it. Using PCA obtain significant features of it. Apply supervised learning method to classify the bio-signal.				6 hours
5.	Record your own speech in three different media and compare the speech signals. Estimate the $h(n)$ of your two medias (different mobiles) by assuming one of them as your $x(n)$. Use a linear approach in obtaining the result 1 and use deconvolution to obtain the result 2 and compare both the results.				6 hours
	Total Laboratory Hours:				30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course code	Course Title	L	T	P	C
BBMD202L	Bio Signal Analysis	2	0	0	2
Pre-requisite	BECE202L	Syllabus version			
		1.0			
Course Objectives					
1. To understand the fundamentals of biomedical signal acquisition and signal classification.					
2. To impart knowledge about physiological signal processing and analysis.					
3. To apply adaptive filtering techniques for cancelling noise and interference in the various bio-signals.					
Course Outcome					
1. Examine the basic signal processing for bio-signals.					
2. Illustrate the knowledge about spectral analysis.					
3. Investigate the cardiological signal processing methods.					
4. Formulate and study an algorithm for bio-signal processing in frequency domain.					
5. Describe an adaptive filtering algorithms for biosignals.					
Module:1	Physiological Signals	3 hours			
Nature of biomedical signals – Objectives of biomedical signal analysis – difficulties in bio medical signal analysis – Noises – Random – Structured and Physiological noises – Filters – Time domain filters and frequency domain filters.					
Module:2	Spectrum Analysis	4 hours			
Detection of Events and Waves – Derivative-based methods for QRS detection – Pan-Tompkins algorithm for QRS detection – Cross Spectral techniques and Coherence analysis of EEG signals – Matched filters – Homomorphic filtering.					
Module:3	Time Series Analysis	4 hours			
Time series analysis – Characterization of nonstationary signals and dynamic systems – Non- stationary process – Fixed segmentation – Adaptive segmentation – RLS Lattice filter – Application in EEG, PCG signals – Time varying analysis of Heart-rate variability.					
Module:4	Frequency Domain characterization	4 hours			
The Fourier Spectrum – Estimation of the Power Spectral Density Function Measures Derived from PSDs – Parametric System Modeling – Autoregressive or All-pole Modeling – Application in HRV, PCG signals.					
Module:5	Adaptive Filtering	4 hours			
Optimal Filtering – The Wiener Filter – Adaptive Filters for Removal of Interference in FECCG – Improved adaptive filters in FECCG – Application in muscle contraction interference.					
Module:6	Wavelets and Bio signal Classification	4 hours			
Discrete wavelet transform – Short time Fourier transform and spectrogram – Dyadic wavelet transform – multiresolution signal decomposition – Wavelet packets – Signal Pattern Classification – Probabilistic Models and Statistical Decision – Logistic Regression Analysis.					
Module:7	Time Frequency and Multivariate Analysis	5 hours			
Back propagation neural network based classification – Application in Normal versus Ectopic ECG beats – Measures of Diagnostic Accuracy and Cost – Multivariate component analysis – PCA – ICA – Application in Detection of Knee-joint Cartilage Pathology.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					
30 hours					
Text Book(s)					
1.	Rangaraj.M.Rangayyan, “Biomedical Signal Analysis”, 2nd edition 2016, IEEE press, New York.				
Reference Books					

1.	Katarzyna J. Blinowska and Jaroslaw Zygierecz, "Practical biomedical signal analysis using MATLAB", 2nd edition, CRC press 2022, Florida.		
2.	Sri Krishnan, "Biomedical signal analysis for connected healthcare" 1st edition 2021, Academic Press Elsevier, United Kingdom.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test.			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BBMD201L	Biomedical Instrumentation and Measurements - II	3	0	0	3
Pre-requisite	BBMD102L, BBMD102P	Syllabus version			
		1.0			
Course Objectives					
1. To discuss the various functional blocks in diagnostic and therapeutic equipment. 2. To impart knowledge about the biomedical equipment so that the student can design, calibrate, and operate with care and safety.					
Course Outcome					
1. To assess the functioning of cardiac pacemakers and defibrillators to distinguish the different levels of equipment used in operation theatres. 2. To conceptualize and design user specific first end medical equipment. 3. To inspect and interpret the functioning of therapeutic and surgical equipment 4. To propose designs for radiotherapy equipment and analyze the functioning of Drug delivery systems. 5. To communicate effectively to impart physical science concepts and understand how they can be used in medical diagnostics and therapeutics.					
Module:1	Cardiac Pacemakers and Defibrillators	6 hours			
Need for Cardiac Pacemaker, External Pacemakers, Implantable Pacemakers, Pacing System Analyser, Need for a Defibrillator, DC Defibrillator, Implantable Defibrillators, Pacer—cardioverter—defibrillator, Defibrillator Analysers.					
Module:2	Laser and Surgical Instruments	6 hours			
Principle of Surgical Diathermy, Diathermy Machine, Surgical Diathermy Analysers, Laser Applications in Biomedical Field: The Laser, Pulsed Ruby Laser, Nd-YAG Laser, Helium-Neon Laser, Argon Laser, CO2 Laser, Excimer Lasers, Semiconductor Lasers, Laser Safety.					
Module:3	Physiotherapy and Electrotherapy Equipment	6 hours			
Short-wave Diathermy, Microwave Diathermy, Ultrasonic Therapy Unit, Pain Relief Through Electrical Stimulation, Bladder Stimulators, Cerebellar Stimulators.					
Module:4	Haemodialysis Machines and Lithotriptors	6 hours			
Artificial, Dialyzers, Membranes for Haemodialysis, Haemodialysis Machine, Portable Kidney Machines. Lithotriptors, Extra-corporeal Shock-wave Therapy.					
Module:5	Anaesthesia Machine and Ventilators	6 hours			
Need for Anaesthesia, Anaesthesia Machine, Electronics in the Anaesthetic Machine, Ventilators, Types of Ventilators, Modern Ventilators, High Frequency Ventilators, Humidifiers, Nebulizers and Aspirators.					
Module:6	Radiotherapy Equipment	6 hours			
Use of High Voltage X-ray Machines, Development of Betatron, Cobalt-60 Machine, Medical Linear Accelerator Machine.					
Module:7	Automated Drug Delivery Systems	7 hours			
Infusion Pumps, Components of Drugs Infusion Systems, Implantable Infusion Systems, Closed-loop Control in Infusion Systems, Examples of Typical Infusion Pumps.					
Module:8	Contemporary Issues	6 hours			
	Total Lecture hours:	45 hours			
Text Book(s)					
1.	R.S. Khandpur Hand Book of Biomedical Instrumentation, 3 rd edition, – Tata McGraw Hill publication, New Delhi, 2014.				
Reference Books					
1.	John G. Webster. “Medical Instrumentation Application and Design”. 5 th edition. John				

	Wiley and sons, NewYork, 2020.		
2.	Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, PHI, New Delhi, 2015.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BBMD102P	Biomedical Instrumentation and Measurements - I Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To revise the basics of medical instrumentation and to familiarize them with the basic principle, working and design of various automated diagnostic equipment.					
2. To elaborate the need of minimally invasive techniques in medical field and to develop the understanding towards the medical laboratory equipment.					
3. To deliver the awareness towards shocks and hazards.					
Course Outcome					
1. To calibrate and trouble-shoot the basic instruments and to measure various parameters related to medical application.					
2. To develop instrumentation systems for various automated biomedical equipment.					
3. To design an instrument for medical applications for the changing demand.					
Indicative Experiments					
1.	Measurement of Blood Pressure using sphygmomanometer	2 hours			
2.	Analyze Instrumentation amplifier for biomedical signals	2 hours			
3.	Design pulse oximeter and segregate the second derivative to detect Heart ailments.	2 hours			
4.	Design an ECG set-up to record three lead ECG and measure the R-R interval, Heart Rate and the cardio vector.	4 hours			
5.	Simulate the real time EEG monitoring and measure the amplitude and frequency of Alpha, Beta, Gamma and Delta waves.	3 hours			
6.	Hands on training and calibration of Auto analyzer and coulter counter.	2 hours			
7.	Design and develop a hearing aid to improve the hearing capability.	3 hours			
8.	Observe the real time patient monitoring system (Visit to Hospital)	6 hours			
9.	Observe the patient safety systems followed in hospital set-up (Visit to Hospital).	6 hours			
	Total Laboratory Hours:	30 hours			
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course code	Course Title	L	T	P	C
BBMD102L	Biomedical Instrumentation and Measurements - I	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To elaborate the development of biomedical instrumentation and its application in medical field, and the concepts behind measuring the blood pressure, cardiac output and heart sounds. 2. To revise the basics of EEG and to introduce the concepts of measuring the brain activity, and to familiarize them with the basic principle, working and design of various automated diagnostic equipment related to ENT and ophthalmology. 3. To elaborate the need of minimally invasive techniques in medical field and to develop the understanding towards the medical laboratory equipment. 4. To deliver the awareness towards shocks and hazards.					
Course Outcome					
1. To furnish information on the development of biomedical instrumentation and its application in medical field. 2. To calibrate and trouble-shoot the basic instruments and to measure various parameters related to medical application. 3. To critically analyze the basics of non-invasive diagnostic techniques and to implement user-defined designs for diagnostic equipment. 4. To develop instrumentation systems for various automated biomedical equipment 5. To design an instrument for medical applications for the changing demand.					
Module:1	Medical Instrumentation	5 hours			
Physiological System of Human Body, Sources of Biomedical Signals, Basic Medical Instrumentation System, Performance Requirements of Medical Instrumentation Systems, Intelligent Medical Instrumentation Systems, General Constraints in Design of Medical Instrumentation Systems, Regulation of Medical Devices.					
Module:2	Recording Systems and Biomedical Recorders	5 hours			
Basic Recording System, General Considerations for Signal Conditioners, Preamplifiers, Main Amplifier and Driver Stage, Writing Systems, Electrocardiograph (ECG), Phonocardiograph (PCG), Electroencephalograph (EEG), Electromyograph (EMG), Biofeedback Instrumentation.					
Module:3	Patient Monitoring Systems	4 hours			
Cardiac Monitor, Bedside Patient Monitoring Systems, Central Monitors, Measurement of Heart Rate and Pulse Rate, Blood Pressure Measurement, Measurement of Respiration Rate.					
Module:4	Oximeters, Blood Flowmeters and Pulmonary Function Analysers	4 hours			
Oximetry: Ear Oximeter, Pulse Oximeter, Blood Flowmeters: Ultrasonic Blood Flowmeters, NMR Blood Flowmeter, Laser Doppler Blood Flowmeter. Pulmonary Function Analysers: Pulmonary Function Measurements, Spirometry, Pneumotachometers, Pulmonary Function Analyzers, Respiratory Gas Analyzers.					
Module:5	Clinical Laboratory Instruments	4 hours			
Colorimeters, Spectrophotometers, Automated Biochemical Analysis Systems, Clinical Flame Photometers, Complete Blood Gas Analyzer, Coulter Counters.					
Module:6	Audiometers and Hearing Aids	3 hours			
Basic Audiometer, Pure Tone Audiometer, Speech Audiometer, Evoked Response Audiometry System, Calibration of Audiometers, Hearing Aids.					
Module:7	Patient Safety	3 hours			

Electric Shock Hazards, Leakage Currents, Safety Codes for Electromedical Equipment, Electrical Safety Analyzer, Testing of Biomedical Equipment.			
Module:8	Contemporary Issues		2 hours
	Total Lecture hours:		30 hours
Text Book(s)			
1.	R.S. Khandpur Hand Book of Biomedical Instrumentation, 3 rd edition, – Tata McGraw Hill publication, New Delhi, 2014.		
Reference Books			
1.	Joseph Carr, Brown, Introduction to Biomedical Equipment, 4 th edition, Pearson, 2015.		
2.	Leslie Cromwell, “Biomedical Instrumentation and measurement”, 2 nd edition, PHI, New Delhi, 2015.		
3.	John G. Webster, “Medical Instrumentation Application and Design”, 5 th edition, John Wiley and sons, New York, 2015.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test.			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BBMD101P	Anatomy and Physiology Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To discuss the insights of skeletal system and bones of the human body.					
2. To discover the different parts of human organs.					
3. To identify the different types of blood groups and blood matching.					
Course Outcome					
The student will be able to					
1. Conceive the engineering knowledge and basic concepts of human bones and skeletal system.					
2. Identify the different parts of various organs of the human body.					
3. Demonstrate the different parts of the brain and its models.					
4. Identify the importance of different types of blood group and its evaluation.					
5. Interpret and analyze the mechanism of pulse and blood pressure.					
Indicative Experiments					
1.	Demonstration of skeletal system and identification of bones of human skeleton				6 hours
2.	Demonstration of parts of the brain on the models				6 hours
3.	Demonstration of thoracic, abdominal and pelvic organs				6 hours
4.	Evaluation of blood groups				6 hours
5.	Analysis of pulse and blood pressure				6 hours
	Total Laboratory Hours:				30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course code	Course Title	L	T	P	C
BBMD101L	Anatomy and Physiology	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To discuss insight into the human body structure and function.					
2. To discover the physiology of different organs and systems of the human body.					
3. To identify the various nutritional aspects and biomolecules of human body.					
Course Outcome					
At the end of the course, the student will be able to					
1. Conceive the engineering knowledge and basic concepts of biology including cell and its biomolecules.					
2. Interpret and analyze the problem statements involved in chemical coordination using various systems of the human body.					
3. Analyze and apply the principles and commit to professional ethics and the concept of biological practice in healthcare.					
4. Interpret and evaluate the mechanism of body fluids and human skeleton.					
5. Identify the importance of biology and ability to engage in life-long learning for technological change.					
Module:1	Cells, tissues, organization of the body and its nutrition	4hours			
The Cell structure and functions – Transport across the cell membrane – Tissues – Tissue regeneration – Organisation of the body – Anatomical terms – Cavities if the body – Disorders of cells and tissues – Carbohydrates – Proteins – Fats – Vitamins – Mineral salts.					
Module:2	Communication through blood and Cardiovascular system	4 hours			
Composition of blood – Cellular content of blood – Erythrocytes – Development and life span of RBC's – Leukocytes – Thrombocytes – Erythrocyte disorders – Leukocyte disorders – Hemorrhagic diseases - Blood vessels – Heart – Circulation of the blood - Diseases of the heart – Disorders of blood pressure.					
Module:3	The nervous system	4 hours			
Neurones – Central nervous system – Brain – Spinal cord – Peripheral nervous system – Autonomic nervous system – Functions – Response of nervous tissue to injury – Disorders of the brain – Diseases of the spinal cord – Tumors of the nervous system.					
Module:4	The Special senses	4 hours			
Hearing and the ear – Physiology of hearing – Balance and the ear – Sight and the eye – Structure and physiology of sight – Sense of smell - Physiology of smell – Sense of taste – Physiology of taste – Disease of the ear – Diseases of the eye – Refractive errors of the eye.					
Module:5	The endocrine system	4 hours			
Pituitary gland and hypothalamus – Disorders – Thyroid gland – Disorders – Parathyroid gland Disorders – Adrenal gland – Pancreatic islets - Disorders– Pineal gland – Thymus gland – Local hormones.					
Module:6	The respiratory system	4 hours			
Nose and nasal cavity – Pharynx – Larynx – Trachea – Broncho and smaller air passages – Bronchioles - alveoli – Lungs – Respiration – Disorders of upper respiratory tract – Diseases of bronchi – Disorders of the lungs.					
Module:7	The digestive system and The Skeletal system	4hours			
Organs of the digestive system – Structure of alimentary canal – Mouth – Salivary glands – Oesophagus – Stomach – Large intestine – Pancreas – Liver – Biliary tract – Metabolism					

Diseases associated with digestive system. Bones – Types of bones – Bone structure – Development of bone tissues – Functions of bones – Axial skeleton – Skull – Cranium – Thoracic cage – Appendicular skeleton – Healing of bones – Diseases of bones – Infection – Developmental abnormalities of bone.			
Module:8	Contemporary Issues		2 hours
	Total Lecture hours:		30 hours
Text Book(s)			
1.	Ross and Wilson, Anatomy and Physiology in Health and Illness, 13Ed (1e), 2018.		
Reference Books			
1.	Guyton and Hall, Textbook of Medical Physiology, Elsevier India, 2 nd Edition (South Asia), 2019		
2.	Tortora G.J, Anatomy & Physiology with Workbook, 2017		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test.			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
BECE401P	Computer Communications and Networks Lab	0	0	2	1
Pre-requisite	BECE306L, BECE306P	Syllabus Version			
		1.0			
Course Objectives:					
1. To familiarize the students with the basic terminologies and concepts of OSI, TCP/IP reference model and functions of various layers. 2. To make the students understand the design and performance issues associated with the functioning of LANs and WLANs. 3. To introduce the students to analyze the IP addressing and basics of transport and application layer protocols.					
Course Outcome:					
The students will be able to: 1. Analyze the performance of internetworking devices and network topologies using simulation tools. 2. Analyze the performance of error detection and medium access control protocols using simulation tools. 3. Implement and analyze the routing algorithms and transport layer protocols using simulation tools.					
List of Challenging Experiments (Indicative)					
Task 1	Simulation and performance analysis (in terms of PDR, delay) of different network topologies and queuing mechanisms.	6 hours			
Task 2	Analyze the spanning tree algorithm by varying the priority among the switches.	4 hours			
Task 3	Simulation of framing and error detection schemes.	4 hours			
Task 4	Simulation and performance analysis of different Medium Access Control schemes.	4 hours			
Task 5	Implementation of various routing algorithms to compute the shortest path.	6 hours			
Task 6	Analysis of transport layer protocols and congestion control.	6 hours			
Total Laboratory Hours		30 hours			
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE401L	Computer Communications and Networks	3	0	0	3
Pre-requisite	BECE306L, BECE306P	Syllabus Version			
		1.0			
Course Objectives:					
1. To familiarize the students with the basic terminologies and concepts of OSI, TCP/IP reference model and functions of various layers. 2. To make the students understand the design and performance issues associated with the functioning of LANs and WLANs. 3. To introduce the students to analyze the IP addressing and basics of transport and application layer protocols.					
Course Outcome:					
The students will be able to: 1. Infer the basic concepts of OSI and TCP reference model in computer network protocols and internetworking devices. 2. Examine the LAN bridges such as Transparent Bridges and Source Routing Bridges 3. Deploy the error & flow control mechanism and medium access control. 4. Configure the network with IP address and find the shortest path. 5. Analyze transport layer protocols and congestion control algorithms 6. Understand the fundamentals of DNS, FTP, SMTP, HTTP and network security.					
Module:1	Layered Network Architecture	6 hours			
Evolution of data Networks – Network Topologies –Switching Techniques – Multiplexing – Categories of networks – ISO/OSI Reference Model – TCP/IP Model – Addressing – Network performance metrics.					
Module:2	Internetworking devices	5 hours			
Repeaters – Hubs – Switches – Bridges: Transparent and Source Routing– Routers.					
Module:3	Data Link Layer- Logical Link Control	6 hours			
Error Detection Techniques – ARQ protocols – Framing – HDLC –Point to Point protocol.					
Module:4	Data Link Layer- Medium Access Control	8 hours			
Random access Protocols – Ethernet (IEEE 802.3) – Wireless LAN (IEEE 802.11); Scheduling approaches to MAC – Controlled Access – Token Bus/Ring (IEEE 802.4/5).					
Module:5	Network Layer	8 hours			
Internetworking – IP Addressing – Subnetting – IPv4 and IPv6– Routing – Distance Vector and Link State Routing – Routing Protocols.					
Module:6	Transport Layer	5 hours			
Connection oriented and Connectionless Service – User Datagram Protocol – Transmission Control Protocol – Congestion Control – QoS parameters.					
Module:7	Application Layer	5 hours			
Domain Name System – Simple Mail Transfer Protocol – File Transfer Protocol – Hypertext Transfer Protocol; Network Security and Cryptography– Virtual LAN – VPN – Enterprise Network: Types and Trends – Private Network.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture:			
		45 hours			

Text Book(s)			
1.	Alberto Leon-Garcia, Communication Networks, 2017, 2 nd Edition, Tata McGraw-Hill, USA.		
Reference Books			
1.	Dimitri P. Bertsekas & Robert Gallager, Data Networks, 2013, 2 nd Edition, Prentice Hall, USA.		
2.	W. Stallings, Data and Computer Communications, 2017, 10 th Edition, Pearson Prentice Hall, USA.		
3.	Behrouz A Forouzan, Data Communications and Networking, 2017, 5 th Edition, Tata McGraw-Hill, USA.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
BECE318P	Optical Fiber Communications Lab	0	0	2	1
Pre-requisite	BECE306L, BECE306P	Syllabus version			
		1.0			
Course Objectives					
1. To design the optical communication system and study the signal degradation. 2. To familiarize wavelength division multiplexing techniques and associate components. 3. To estimate the link power budget and rise time budget.					
Course Outcome					
At the end of the course, the students will be able to: 1. Establish the optical link and estimate the design parameters. 2. Analyse the optical amplifiers and evaluate their characteristics. 3. Design and analyse the WDM techniques and components.					
Indicative Experiments					
1.	Design of optical transmission link to analyse the BER performance for different line coding techniques, modulation based on wavelength and length of the fiber.				6 hours
2.	Design and analysis of gain, noise figure and saturation of optical amplifier – EDFA, SOA.				4 hours
3.	Performance analysis of wavelength division multiplexing (WDM) techniques and passive optical components (Optical coupler, Isolator, Circulator, FBG & OADM)				8 hours
4.	Analyse the different dispersion compensation techniques and fiber non-linear effects.				8 hours
5.	Design of point-to-point optical system, estimate the power and rise-time budget and detect the fiber faults using OTDR.				4 hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
BECE318L	Optical Fiber Communications	3	0	0	3
Pre-requisite	BECE306L, BECE306P	Syllabus version			
		1.0			
Course Objectives					
1. To understand the principles of optical fibers and their signal degradation.					
2. To familiarize with the fundamentals of optical sources and detectors used in communications.					
3. To learn WDM techniques and its components in contemporary optical communication systems.					
Course Outcomes					
At the end of the course, the students will be able to:					
1. List the fundamental optical laws, structures and waveguides.					
2. Comprehend the various signal degradation in the fiber optical communication.					
3. Design the optical transmitters and receivers and evaluate their performances.					
4. Estimate the system requirements for point to point communication.					
5. Examine the significance of WDM techniques and their applications.					
6. Comprehend and analyse the performance of the various optical amplifiers.					
Module:1	Optical Fiber: Structures, Waveguides	6 hours			
Key elements of optical fiber system-Ray optics, Mode theory, Geometrical-Optics Description, Fiber Types - specialty fibers.					
Module:2	Signal Degradation	7 hours			
Attenuation-Absorption, Scattering, Bending losses, Dispersion-Material, Waveguide Dispersion, Polarization Mode Dispersion, Intermodal dispersion, Mode Transit time, Dispersion-Induced Limitations, Nonlinear Optical Effects- SRS, SBS, SPM, CPM, FWM.					
Module:3	Optical Transmitters	6 hours			
Sources: LED-Structures-Quantum Efficiency, Power and Modulation Bandwidth- LASER-DFB, DBR, VCSEL, Quantum Efficiency, Modulators - Direct and external modulators, Transmitter Design.					
Module:4	Optical Receivers	7 hours			
Photodetector-PIN, APD, Receiver Design, Receiver Noise-CNR&SNR), Receiver Sensitivity, Quantum limit, Sensitivity Degradation, Receiver Performance-Probability of error, Bit Error rate, Eye-Diagram.					
Module:5	Digital links and Measurements	6 hours			
Digital links: Point-to-Point Links-System Consideration-Link power budget-Rise time budget, System performance- Attenuation, Dispersion measurements-OTDR.					
Module:6	WDM Concepts and Components	7 hours			
Overview of WDM, Fiber Coupler-Wave guide coupler-Star couplers, Isolators and Circulators - Fiber Bragg Grating, Filters, Multiplexers, WDM System Performance Issues- Compensation techniques.					
Module:7	Optical Amplifiers	4 hours			
Semiconductor Optical Amplifiers, Raman Amplifiers, Erbium-Doped Fiber Amplifiers.					
Module:8	Contemporary Issues	2 hours			

	Total Lecture hours:		45 hours
Text Book(s)			
1.	Gerd Keiser, Optical Fiber Communications, 2017, 5 th Edition, McGraw Hill Education, India.		
Reference Books			
1.	Conway, E., Optical Fiber Communications Principles and Practice, 2018, 1 st Edition, ED-TECH Press, United Kingdom.		
2.	Singal, T. L. Optical Fiber Communications: Principles and Applications, 2017, Cambridge University Press, India.		
3.	Keiser, G., Fiber Optic Communications, 2021, 1 st Edition, Springer, Singapore		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
BECE317P	Wireless and Mobile Communications Lab	0	0	2	1
Pre-requisite	BECE306L, BECE306P	Syllabus version			
		1.0			
Course Objectives					
1. To analyse the fundamentals of multipath fading and propagation models. 2. To understand the principles of multicarrier modulation. 3. To demonstrate the diversity techniques and MIMO Technology.					
Course Outcome					
Students will be able to 1. Examine and estimate wireless channel using path loss models. 2. Demonstrate the principles of multicarrier modulation. 3. Implement the diversity techniques and MIMO concept in different wireless applications.					
Indicative Experiments					
1.	Study how call blocking probability varies as the load on a GSM network is continuously increased using Network Simulator	4 Hours			
2.	To study the effect of various fading channels such as Rayleigh, Ricean and various noise channel such as AWGN and Laplacian noise	4 Hours			
3.	Simulate to compute the pathloss of urban, suburban and rural environment for LTE/WiMAX/WLAN system using free space, Ericsson, COST 231, ECC, Hata and SUI model	4 Hours			
4.	Testing and validating principles of Pathloss in Mobile Radio Propagation through Smartphone and CRFO	2 Hours			
5.	Throughput analysis of LTE network with respect to varying distance between the ENB and UE (User Equipment)	2 Hours			
6	Write a program to analyse the Bit Error Rate (BER) performance of OFDM using BPSK, QPSK and QAM modulation schemes.	4 Hours			
7.	Write a program to analyse the following techniques to reduce the PAPR in OFDM. (i)Selective Mapping (SLM) technique (ii) Partial Transmit (PTM) Technique. (iii) Windowing Technique.	2 Hours			
8.	Comparison of MRC and EGC schemes with SISO fading	2 Hours			
9.	Comparison of ZF and MMSE MIMO receivers	4 Hours			
10	HF Radio Channel Simulation using a real-time radio simulator	2 Hours			
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		28-07-2022			
Approved by Academic Council		No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
BECE317L	Wireless and Mobile Communications	3	0	0	3
Pre-requisite	BECE306L, BECE306P	Syllabus version			
		1.0			
Course Objectives:					
1. To familiarize the concepts of wireless communication. 2. To teach students the fundamentals of multipath fading and propagation models. 3. To acquaint students with different generations of mobile networks. 4. To describe the diversity and MIMO schemes as applied in wireless communication.					
Course Outcome:					
The students will be able to 1. Infer the wireless channel using path loss models and interpret the impact of multipath channel parameters. 2. Examine the functions and services of cellular networks. 3. Demonstrate the principles of multicarrier modulation. 4. Select a suitable diversity technique to combat the multipath fading effects. 5. Identify suitable MIMO techniques to enhance the spectrum efficiency. 6. Describe the features of next generation wireless technologies.					
Module:1	Mobile Radio Propagation: Large Scale Fading	9 hours			
Overview of Wireless Communication, Cellular concept – Frequency reuse – Channel assignment strategies – Handoff strategies – Interference and system capacity – Trunking and grade of service – Improving coverage and capacity in cellular system. Propagation mechanisms, Free space model, Two ray model, Outdoor and indoor propagation models, Link budget design.					
Module:2	Mobile Radio Propagation : Small Scale Fading	6 hours			
Small scale multipath propagation, Parameters of multipath channels, Types of small scale fading, Rayleigh and Rician fading.					
Module:3	Wireless Systems and Standards	5 hours			
AMPS,GSM, GPRS, EDGE, UMTS, LTE, LTE-A.					
Module:4	OFDM Technology	5 hours			
Introduction and Challenges in Multicarrier Systems, OFDM System Model - IFFT/ FFT Transceiver Mathematical Model - Cyclic Prefix, PAPR and reduction techniques - SNR and BER performance - ICI-SC-FDMA.					
Module:5	Diversity Techniques	6 hours			
Multiple Antenna Wireless Systems-System Model, Types of Diversity: Antenna, Frequency, Time; Deep Fade Analysis with Diversity, Optimal Receiver Combining, MRC, EGC, Diversity Order.					
Module:6	MIMO Technology	7 hours			
MIMO System Model – Zero Forcing and Minimum Mean Square Error receivers - Singular Value Decomposition - Channel Capacity - Optimal Water filling Power Allocation - Beam forming - Spatial Multiplexing, BLAST Architectures, Distributed MIMO.					
Module:7	Next Generation Wireless Communication	5 hours			
5G Wireless Technologies - NR Standard, filter bank multicarrier, Non-orthogonal multiple access, D2D, small cells, mmWave, Index Modulation - 6G Key enablers - Reconfigurable					

intelligent surfaces.			
Module:8		Contemporary Issues	
		2 hours	
		Total Lecture hours:	
		45hours	
Text Book(s)			
1.	Rappaport, T.S., Wireless Communications: Principles and Practice, 2018, (Reprint), Pearson Education, Noida, India.		
Reference Books			
1.	Andrea Goldsmith, Wireless Communications, 2020, 2 nd Edition, Cambridge University Press		
2.	Aditya K. Jagannatham," Principles of Modern Wireless Communications Systems", 2015, McGraw Hill Education		
3.	T L Singal, Wireless Communications, 2014, (Reprint), Tata McGraw Hill Education, 1 st edition, New Delhi, India.		
4.	Keith Q T Zhang, Wireless Communications: Principles, Theory and Methodology, 2016, 1 st edition, John Wiley & Sons, West Sussex, UK.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
BECE306P	Digital Communication Systems Lab	0	0	2	1
Pre-requisite	BECE206L, BECE206P	Syllabus version			
		1.0			
Course Objectives					
1. To implement various waveform coding techniques. 2. To analyze various baseband and bandpass signals for effective communication. 3. To understand the principles and importance of multiple access techniques in the context of communication.					
Course Outcome					
Students will be able to 1. Construct and analyse various waveform coding techniques. 2. Design the circuits for band pass modulators and evaluate their performance. 3. Implement spread spectrum techniques for multiple access communication.					
Indicative Experiments					
1.	Generation and reconstruction of PCM, DPCM and DM				4 Hours
2	Generation of baseband signals using various line coding formats for the given binary sequence				4 Hours
3.	Generation and detection of bandpass modulation techniques				12 Hours
4.	BER analysis of bandpass modulation techniques				2 Hours
5	Generation of PN sequence and verification of its properties				4 Hours
6.	Implementation of multiple access schemes				4 Hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE306L	Digital Communication Systems	3	0	0	3
Pre-requisite	BECE206L, BECE206P	Syllabus version			
		1.0			
Course Objectives:					
1. To understand the transmitter and receiver blocks of various waveform coding techniques. 2. To analyze various line coding techniques in time and frequency domains. 3. To identify the role of baseband, bandpass formats and information theory for effective transmission of signals, combat ISI and to increase the reliability of transmission. 4. To understand the principles and importance of spread spectrum and multiple access in the context of communication.					
Course Outcomes:					
Students will be able to					
1. Comprehend the sampling and quantization process to recover the original signal 2. Analyse the performance of various waveform and Line coding techniques. 3. Design the various baseband pulses for ISI free transmission over finite bandwidth channels. 4. Examine the BER and bandwidth efficiency of the Bandpass modulation techniques. 5. Analyse the digital communication system with spread spectrum modulation. 6. Infer the elements of information theory.					
Module:1	Sampling Process	4 hours			
Block diagram of a digital communication system, bandwidth of signals. Sampling theorem - quadrature sampling of bandpass signals, Reconstruction of a message from its samples, Practical aspects of sampling and signal recovery.					
Module:2	Waveform Coding Techniques	6 hours			
Pulse Code Modulation (PCM) - Uniform quantization, Quantization noise, Signal-to-Noise Ratio, Robust quantization. Differential pulse code modulation (DPCM), Delta Modulation (DM) - Quantization noise in DM, Adaptive Delta Modulation.					
Module:3	Line Codes	6 hours			
Representation of line codes – Unipolar, Polar, Bipolar using NRZ and RZ, Manchester, Polar Quaternary codes, Differential encoding, Properties and applications of line codes – Power spectral density of line codes.					
Module:4	Baseband System	5 hours			
Baseband data transmission of binary data - Inter Symbol Interference (ISI), Nyquist criterion for zero ISI, Raised cosine filtering, correlative coding (duo binary and modified duo binary coding), eye pattern – Equalization.					
Module:5	Bandpass system	12 hours			
Gram-Schmidt Orthogonalization Procedure. Correlation and Matched filter receiver. Coherent modulation techniques - BASK, BPSK, BFSK, QPSK, MSK, Higher-order PSK and QAM, BER and Bandwidth efficiency analysis. Non-coherent modulation techniques – BASK, BFSK, DPSK.					
Module:6	Spread Spectrum and Multiple Access Techniques	5 hours			
Principles of spread spectrum - Generation of PN sequence and its properties, Direct Sequence Spread Spectrum (DSSS), Processing gain, Probability of error, Anti-jam characteristics, Frequency- Hop Spread Spectrum (FHSS). Multiple access techniques - TDMA, FDMA, CDMA, SDMA.					

Module:7	Introduction to Information Theory	5 hours
Entropy, Mutual information and channel capacity theorem. Fundamentals of error correction - Hamming codes.		
Module:8	Contemporary issues	2 hours
	Total lecture hours:	45 hours
Text Book(s)		
1.	Simon Haykin, Digital Communications, 2017, 1 st Edition, John Wiley, India.	
Reference Books		
1.	John G. Proakis, Masoud Salehi, Digital Communication, 2018, 5 th Edition (Indian edition), Mc Graw Hill Education, India.	
2.	Bernard Sklar and Fredric J. Harris, Digital Communications: Fundamentals and Applications, 2020, 3 rd Edition, Pearson , UK.	
3.	B P Lathi, Zhi Ding, Modern Digital And Analog Communication Systems, 2017, 4 th Edition, Oxford university Press, India.	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		
Recommended by Board of Studies		14-05-2022
Approved by Academic Council	No. 66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
BECE305P	Antenna and Microwave Engineering Lab	0	0	2	1
Pre-requisite	BECE205L	Syllabus version			
		1.0			
Course Objectives					
1. To apply the theoretical knowledge and explore the designing principles of various antennas and microwave devices.					
2. To design the various microwave antenna and devices using a suitable design tools.					
Course Outcome					
Students will be able to					
1. Measure the various parameters and comprehend the radiation pattern of wired antennas.					
2. Measure the performance of microwave passive devices using test bench setup and also simulate and analyze microwave passive and active circuits.					
3. Design the microwave circuits to suit the needs of industry.					
Indicative Experiments					
Hardware Experiments:					
1.	Measurement of antenna input impedance	2 hours			
2.	Measurement of antenna radiation pattern	2 hours			
3.	Measurement of S-parameters for E-plane, H-plane and Magic Tee	4 hours			
4.	Measurement of S-parameters for Directional Coupler	2 hours			
5.	Measurement of S-parameters for Isolator and Circulator	2 hours			
6.	Measurement of S-parameters of MIC devices	4 hours			
Experiments using Simulation tools:					
7.	Design of Wilkinson power divider	2 hours			
8.	Design of branch line and Rat race coupler	2 hours			
9.	Design of low pass filters: Richards and Stepped impedance method	2 hours			
10.	Design of matching circuits using quarter wave & single stub.	4 hours			
11.	Design of dipole antenna	2 hours			
12.	Design of Rectangular patch antenna	2 hours			
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE305L	Antenna and Microwave Engineering	3	0	0	3
Pre-requisite	BECE205L	Syllabus version			
		1.0			
Course Objectives					
1. To introduce and discuss the mechanism for antenna parameters, radiating principles, fundamental characteristics and design concepts of HF, UHF, Microwave antennas and arrays. 2. To design and analyse various passive and active microwave circuits. 3. To familiarize the operational principles of microwave sources and to characterize microwave networks.					
Course Outcome					
Students will be able to					
1. Examine the radiation mechanism of electromagnetic fields and identify the various antenna parameters. 2. Apply the design criteria to Linear, HF, UHF, microwave antenna and arrays. 3. Comprehend the performance of different microwave sources and ferrite devices. 4. Design and analyze the passive components at microwave frequencies. 5. Design and analyze the various passive circuits at microwave frequencies. 6. Infer the importance of high frequency transistors to design microwave amplifiers.					
Module:1	EM Radiation and Antenna Parameters	8 hours			
Radiation mechanism - single wire, two wire and current distribution, Hertzian dipole, Dipole and monopole - Radiation pattern, beam width, field regions, radiation power density, radiation intensity, directivity and gain, bandwidth, polarization, input impedance, efficiency, antenna effective length and area, antenna temperature. Friis transmission equation, Radar range equation.					
Module:2	Linear and Planar Arrays	6 hours			
Two element array, N-element linear array - broadside array, End fire array - Directivity, radiation pattern, pattern multiplication. Non-uniform excitation - Binomial, Chebyshev distribution, Arrays: Planar array, circular array, Phased Array antenna (Qualitative study).					
Module:3	HF, UHF and Microwave Antennas	7 hours			
Wire Antennas - long wire, loop antenna - helical antenna. Yagi-Uda antenna, Frequency independent antennas - spiral and log periodic antenna - Aperture antennas – Horn antenna, Parabolic reflector antenna - Microstrip antenna.					
Module:4	Microwave Sources	5 hours			
Microwave frequencies and applications, Microwave Tubes: TWT, Klystron amplifier, Reflex Klystron & Magnetron. Semiconductor Devices: Gunn diode, Tunnel diode, IMPATT – TRAPATT - BARITT diodes, PIN Diode.					
Module:5	Microwave Passive components	6 hours			
Microwave Networks - ABCD, ‘S’ parameter and its properties. E-Plane Tee, H-Plane Tee, Magic Tee and Multi-hole directional coupler. Principle of Faraday rotation, isolator, circulator and phase shifter.					
Module:6	Microwave Passive circuits	7 hours			
T junction and resistive power divider, Wilkinson power divider, branch line coupler (equal & unequal), Rat Race Coupler, Filter design: Low pass filter (Butterworth and Chebyshev) - Richards transformation and stepped impedance methods.					

Module:7	Microwave Active Circuits	4 hours	
Microwave transistors, Microwave amplifiers: Two port power gains, stability of the amplifier, Microwave oscillators.			
Module:8	Contemporary issues	2 hours	
	Total Lecture hours:	45 hours	
Text Book(s)			
1.	C.A. Balanis, Antenna Theory - Analysis and Design, 2016, 4 th Edition, Wiley& Sons, New York, USA.		
2.	D. M. Pozar, Microwave engineering, 2013, 4 th Edition, Wiley & Sons, USA.		
Reference Books			
1.	R Ludwig, Gene Bogdanov, RF Circuit design: Theory and applications, 2013, 2 nd Edition, Pearson India.		
2.	John D Krauss, Antennas for all Applications, 2008, 4 th Edition, Tata McGraw Hill, India.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
BECE304P	Analog Communication Systems Lab	0	0	2	1
Pre-requisite	BECE206L, BECE206P	Syllabus version			
		1.0			
Course Objectives:					
1. Procedurally troubleshoot, construct and analyse modulators and demodulators in analog communication systems.					
2. Examine the effect of modulation index and noise in analog communication systems.					
3. Inculcate hands-on experience, by integrating theory into practical experiments.					
Course Outcome:					
Students will be able to					
1. Obtain an insight into the functionalities and validate the performance of analog modulators and demodulators.					
2. Determine the noise measures for analog communication systems.					
3. Sample an analog signal and implement the multiplexing concepts.					
Indicative Experiments					
1.	Design of AM, DSB-SC, SSB-SC modulators and demodulators				8 Hours
2.	Design of FM, PM modulators and demodulators				4 Hours
3.	Design of Superheterodyne receiver - Mixer, Pre-emphasis and De-emphasis				4 Hours
4.	Analyse the noise characteristics of analog communication systems – SNR, Noise voltage, Noise figure and Noise temperature				4 Hours
5.	Design of PAM,PPM,PWM modulators and demodulators				6 Hours
6.	Implementation of TDM and FDM				4 Hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE304L	Analog Communication Systems	3	0	0	3
Pre-requisite	BECE206L, BECE206P	Syllabus version			
		1.0			
Course Objectives:					
1. To explore the architectural elements and models used in analog communication systems. 2. To analyse bandwidth, current, power and transmission efficiency of analog modulations. 3. To understand the functionalities of transmitters and receivers. 4. To comprehend the effect of noise in analog communication systems.					
Course Outcomes:					
Students will be able to 1. List and analyse the key elements of analog communication system. 2. Design the various Amplitude Modulation Schemes and evaluate in terms of its power, bandwidth and transmission Efficiency. 3. Examine the various angle modulation schemes. 4. Infer the working principle of radio transmitters and receivers. 5. Analyse the effect of noise on various analog modulations. 6. Analyse various pulse modulation and multiplexing techniques.					
Module:1	Communication Systems	4 hours			
Need and importance of communication, Elements of communication system - Types of communication systems, Electromagnetic spectrum used in communication, Concept of bandwidth and power, Need for modulation.					
Module:2	Amplitude Modulation (AM)	7 hours			
Amplitude modulation – Single- tone and Multi-tone, Mathematical representation of AM signal, Bandwidth, current, power and transmission efficiency of AM. Generation of AM signal – Square law modulator, Switching modulator. AM demodulation – Envelope detector and Square law demodulator.					
Module:3	Bandwidth and Power Efficient AM Systems	7 hours			
DSB-SC generation – Balanced modulator and Ring modulator. DSB-SC demodulation – Synchronous detection, Effect of phase drift. SSB-SC generation – Filter, Phase shift and Third method. SSB-SC demodulation - Synchronous detection. VSB generation and demodulation. Power, bandwidth and transmission efficiency of DSB-SC, SSB-SC and VSB.					
Module:4	Angle Modulation	10 hours			
Principles of Frequency Modulation (FM) and Phase Modulation (PM) – Relation between FM and PM, Frequency deviation and bandwidth of FM, Narrow band and Wide band FM, Bessel functions and Carson's rule. FM generation and detection. Comparison of amplitude and angle modulation.					
Module:5	Transmitters and Receivers	5 hours			
Radio transmitter - Classification of transmitters - Low level and High level AM Transmitters, FM Transmitter. Radio receiver - Receiver characteristics, Tuned Radio Frequency (TRF) Receiver, Superheterodyne receiver (AM and FM), Choice of IF and oscillator frequencies, Tracking and Alignment – AGC, AFC. Pre-emphasis and De-emphasis.					
Module:6	Noise in Communication Systems	6 hours			
Noise and its types- Noise voltage and power, Signal-to-Noise Ratio (SNR), Noise figure, Noise temperature. Figure of Merit in DSB-SC, SSB-SC, AM and FM receivers.					

Module:7		Pulse Modulation Systems		4 hours	
Sampling theorem - Types of Sampling. Pulse modulation schemes – generation and detection PAM, PPM and PWM, Conversion of PWM to PPM. Multiplexing Techniques – FDM and TDM.					
Module:8		Contemporary Issues		2 hours	
		Total lecture hours:		45 hours	
Text Books					
1.	George Kennedy, Bernard Davis, Electronic Communication Systems, 2017, 6 th Edition, Mc Graw Hill Education, New Delhi, India.				
Reference Books					
1.	Simon Haykin, Communication Systems, 2019, 5 th Edition, Wiley, India.				
2	P. Ramakrishna Rao, Analog Communication, 2017, Tata McGraw Hill Education Pvt Ltd., India.				
3	Herbert Taub and Donald Schilling, Principles of Communication Systems, 2017, 4 th Edition, Mc Graw Hill Education, India.				
4	HweiKsu and Debjani Mitra, Analog and Digital Communication, 2017, 3 rd Edition, McGraw Hill Education, India.				
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE303P	VLSI System Design Lab	0	0	2	1
Pre-requisite	BECE102L, BECE102P	Syllabus version			
		1.0			
Course Objectives :					
The objective of this laboratory is to apply the theoretical knowledge and explore various design style of CMOS Integrated Circuits (IC) design using the latest EDA tools					
Course Outcome :					
On completion of this lab course the students will be able to					
- Analyze the performance of CMOS Inverter circuits on the basis of their operation and working. - Design the semiconductor memory cell, combinational, sequential and arithmetic circuit using CMOS design rules. - Construct layout of CMOS inverter, universal and basic logic gates.					
Indicative Experiments					
1	Parameter extraction for basic cell structure (NMOS and PMOS devices). Analysis of MOS with width variation, body effect and estimation of channel length modulation	2 hours			
2	Design and Analysis of CMOS inverter for arbitrary sizing. - Estimation of Power, Delay, Noise Margin. - Impact of load on performance metrics.	4 hours			
3	Analysis of CMOS inverter for given specification. Impact of sizing on Power, Delay, Noise Margin	2 hours			
4	Analysis of inverter chains using progressive sizing to improve delay performance.	2 hours			
5	Design and Analysis of Universal gates in static CMOS logic Effect of input reordering.	2 hours			
6	Design and Analysis of Boolean Expression (Simple Arithmetic Unit) in static CMOS logic.	2 hours			
7	Design and Analysis of Pass transistor and Transmission gate based circuits	4 hours			
8	Design and Analysis of CMOS sequential circuits (Latches and Flip Flops)	4 hours			
9	Design a CMOS Memory cell (SRAM, DRAM) and verify its operation.	4 hours			
10	Design Layout of CMOS inverter and perform post-layout analysis, DRC, Layout Vs. Schematic, Monte Carlo analysis, Corner analysis and etc.	4 hours			
Total Laboratory Hours		30 hours			
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE303L	VLSI System Design	3	0	0	3
Pre-requisite	BECE102L, BECE102P	Syllabus version			
		1.0			
Course Objectives :					
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Introduction, Types - Read-Only Memory (ROM) Circuits, Static Read-Write Memory (SRAM) and Dynamic Read-Write Memory (DRAM) Circuits.				
Module:8		Contemporary issues		2 hours
Total Lecture Hours:				45 hours
Text Book(s)				
1.	Neil H.Weste, Harris, A. Banerjee, CMOS VLSI Design, A circuits and System Perspective, 2015, 4 th Edition, Pearson Education, Noida, India.			
Reference Book				
1.	Jan M. Rabaey, Anantha Chadrakasan, Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective Paperback, 2016, 2 rd Edition, Pearson Education, India.			
2.	Sung-Mo Kang, Yusuf Liblebici, Chulwoo Kim, CMOS Digital Integrated Circuits: Analysis and Design, 2019, Revised 4th Edition, Tata Mc Graw Hill, New Delhi, India.			
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test				
Recommended by Board of Studies			14-05-2022	
Approved by Academic Council			No. 66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
BECE302L	Control Systems	2	1	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To study the use of transfer function model for the analysis of physical systems and to introduce the components of control system. 2. To provide adequate knowledge in the time response of systems and steady state error analysis along with the understanding of closed-loop and open loop system analysis in frequency domain. 3. To introduce the design of controllers and compensators for the stability analysis. 4. To introduce state variable representation of physical systems and study the stability analysis in state space approach.					
Course Outcomes					
Students will be able to 1. Differentiate between open-loop and closed-loop control systems and obtain the transfer function from the mathematical modeling of physical systems. 2. Determine transient and steady state responses of the system with first and second order and also to analyze its error coefficients. 3. Characterize the system stability using R-H criteria and root locus techniques. 4. Analyze the frequency domain response of the control systems. 5. Design the controllers and compensators to estimate the system stability. 6. Analyze the system in state space model through the concept of controllability and observability.					
Module:1	Control Systems	3 hours			
Basic components of a control system, Applications, Open-loop control system and closed-loop control system, Examples of control system (air conditioner, cruise control, phase-locked loop, etc.), Effects of feedback on overall gain, Types of feedback control system, Linear and non-linear control systems.					
Module:2	Mathematical Modeling of Physical Systems	8 hours			
Difference and differential equations for LTI SISO and MIMO systems, Mathematical modeling of electrical and mechanical systems, Equivalence between the elements of different types of systems, Transfer function of linear systems, Open-loop transfer function and closed-loop transfer function, Block diagram representation, Block diagram reduction techniques, Signal flow graph using Mason's gain formula.					
Module:3	Time Domain Response	6 hours			
Transient response and steady state responses, Time domain specifications, Types of test inputs, Response of first order and second order systems, Steady state error, Static error coefficients, Generalized error coefficients.					
Module:4	Characterization of Systems	5 hours			
Stability – concept and definition, Poles, Zeros, Order and Type of systems; R-H criteria, Root locus analysis.					
Module:5	Frequency Domain Response	7 hours			
Frequency response – Performance specifications in the frequency domain, Phase margin and gain margin, Bode plot, Polar plot and Nyquist plot, Stability analysis in frequency domain.					

Module:6	Controllers and Compensators Design	7 hours
Controllers – P, PI, PID, Realization of basic compensators, Cascade compensation in time domain and frequency domain, Feedback compensation, Design of lag, lead, lag-lead series compensators.		
Module:7	State Space Analysis	7 hours
Dynamic system modeling in state space representation: Diagonal canonical form, Jordan canonical form, Solutions of state equations of LTI system, Conversion from state space model to transfer function model and vice versa, Stability analysis in state spaces: Concept of eigenvalues and eigenvectors, State transition matrix using Cayley-Hamilton theorem, Controllability and observability.		
Module:8	Contemporary Issues	2 hours
	Total Lecture hours:	45 hours
Text Book(s)		
1.	Norman S. Nise, Control Systems Engineering, 2019, 8 th Edition, John Wiley & Sons, New Jersey, USA	
Reference Books		
1.	Farid Golnaraghi and Benjamin C. Kuo, Automatic Control Systems, 2017, 10 th Edition, McGraw-Hill Education, India.	
2.	I.J. Nagarth and M. Gopal, Control Systems Engineering, 2018, 6 th Edition, New Age International Pvt. Ltd., New Delhi, India.	
3.	Gene Franklin, J. Powell and Abbas Emami-Naeini, Feedback Control of Dynamic Systems, 2019, 8 th Edition, Pearson Education, New Delhi, India.	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		
Recommended by Board of Studies		28-02-2023
Approved by Academic Council		No. 69 Date 16-03-2023

Course code	Course Title	L	T	P	C
BECE301P	Digital Signal Processing Lab	0	0	2	1
Pre-requisite	BECE202L	Syllabus version			
		1.0			
Course Objectives					
1. To learn the usage of appropriate tools for realizing signal processing modules.					
Course Outcome					
Students will be able to					
1. Generate the various elementary signals using the DSP processor.					
2. Implement the sampling and reconstruction process.					
3. Design and implement the various systems using the imbibed signal processing concepts.					
Indicative Experiments					
1.	Introduction to TMS320C6748 processor and code composer studio IDE.				2 hours
2.	Generation of elementary signals and illustration of simple signal processing operations on TMS320C6748 processor				6 hours
3.	Sampling and Reconstruction of CT signals, DTFT analysis				6 Hours
4.	Biomedical / Speech / Audio Signal Analysis				6 Hours
5.	Computational analysis using FFT				3 Hours
6.	Design of IIR filter				3 Hours
7.	Design of FIR filter using windowing techniques				4 Hours
Total Laboratory Hours					30 Hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE301L	Digital Signal Processing	3	0	0	3
Pre-requisite	BECE202L	Syllabus version			
		1.0			
Course Objectives					
1. To summarize and analyze the concepts of signals, systems in time and frequency domain with the corresponding transformations. 2. To inculcate the design concepts of analog, digital IIR, FIR filters. 3. To instill diverse structures for realizing digital filters. 4. To infuse the novice concepts of Multirate digital signal processing.					
Course Outcome					
Students will be able to 1. Classify and analyse Signals & Systems along with their time and frequency domain transformations. 2. Simplify Fourier transform computations using swift algorithms. 3. Examine various analog filter design techniques and their digitization. 4. Design FIR and IIR digital filters. 5. Realize digital filters using various system interconnections. 6. Design and formulate Multirate systems.					
Module:1	Discrete Signals, Systems and frequency analysis	6 hours			
Review of Discrete-Time Signals & Systems and frequency analysis - Z- transform: ROC stability / causality analysis, Frequency domain sampling - Sampling rate conversion - Aperiodic correlation estimation - Cepstrum processing - Band limited discrete time signals.					
Module:2	Discrete Fourier Transform, Properties and its applications	6 hours			
DFT – Properties - Linear filtering methods - Frequency analysis of signals using DFT - FFT Algorithm - Radix-2 FFT - Sparse FFT - Practical applications.					
Module:3	Design of Analog Filters	6 hours			
Design techniques for analog filter - Butterworth and Chebyshev approximations - Frequency transformation, Properties - Constant group delay and zero phase filters.					
Module:4	Digital transformation of IIR filters	5 hours			
IIR filter design: Bilinear transformation, Impulse Invariance - Spectral transformation of Digital filters					
Module:5	Design of FIR filters	5 hours			
FIR Filter Design: Design characteristics of FIR filters with linear-phase – Frequency response of linear phase FIR filters – Design of FIR filters using windowing techniques: Rectangular, Bartlett Hamming, Hanning, Blackmann, Kaiser - Phase delay, Group delay					
Module:6	Realization structures for Discrete-Time Systems	7 hours			
Direct, Cascade, Parallel, Lattice and Lattice - Ladder Structures: All pass filter - IIR tapped-cascaded structure. Parallel all pass realization of IIR systems.					
Module:7	Multirate digital signal processing	8 hours			
Introduction-Implementation of Sampling Rate Conversion: Polyphase Filter Structures - Interchange of Filters and Downsamplers / Upsamplers - Polyphase Structures for Decimation and Interpolation Filters - Structures for Rational Sampling Rate Conversion. Discrete Cosine Transform - Wavelet Transform					

Module:8	Contemporary issues		2 hours
	Total Lecture hours:		45 hours
Text Book(s)			
1.	John G. Proakis, Dimitris G Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 2022, 5 th Edition, Pearson, USA		
Reference Books			
1.	A textbook of Digital Signal Processing, R.S.Kaler, M.Kulkarni, Umesh Gupta, 1 st edition, 2019, Dream tech Press, Wiley, India		
2.	James McClellan, Ronal Schaeffer, Mark Yoder, Digital Signal Processing first, 2016, 2 nd edition, Pearson, USA		
3.	Lizhe Tan, Jean Jiang, Digital Signal Processing: Fundamentals and applications, 3 rd edition, 2018, Academic Press, USA		
4.	S.K.Mitra, Digital Signal Processing, 2013, 4 th edition, TMH, New Delhi, India		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
BECE207L	Random Processes	2	1	0	3
Pre-requisite	BECE202L	Syllabus version			
		1.0			
Course Objectives					
1. To familiarize the students with two and multi-random variable theory. 2. To enable the students process the random signals in time and frequency domains. 3. To make the students understand the noise concepts and design a matched filter to increase the Signal to Noise Ratio (SNR).					
Course Outcome					
The students will be able to 1. Compute the probability density functions for multiple random variables 2. Perform transformation on multiple random variables and complex random variables 3. Interpret the random processes in terms of stationarity, statistical independence, and correlation. 4. Compute the power spectral density of the random signals 5. Interpret the effect of random signals on LTI systems output both in the time and frequency domain. 6. Design the Optimum linear systems for extracting signals in the presence of noise.					
Module:1	Continuous and Discrete Multiple Random Variables	6 hours			
Introduction to Random Variables – Vector Random Variables- Joint Distribution and its Properties-Joint Density and its Properties-Joint Probability Mass Function – Conditional Distribution and Density-Statistical Independence –Distribution and Density of Function of Random Variables – Central Limit Theorem.					
Module:2	Operations on Multiple Random Variables	7 hours			
Joint Moments for continuous and discrete random variables – Joint Central Moments – Joint Characteristics Function – Jointly Gaussian Random Variables – Transformations of Multiple Random Variables – Linear Transformation of Gaussian Random Variables – Complex Random Variables.					
Module:3	Random Processes – Temporal Characteristics	7 hours			
Random Process: Classifications. Stationarity and Independence. Time Averages and Ergodic Random process. Characterizing a Random Process: The Mean, Correlation Functions, Covariance Functions, and their Properties-Different processes: Gaussian Random Process- Poisson Random Process, Weiner Process, and Markov process, and Complex Random Process.					
Module:4	Random Processes – Spectral Characteristics	7 hours			
Power Density Spectrum and its Properties-Cross PSD and its properties, Relationship between Correlation and Power Spectrum- Power Spectral density of a WSS discrete Time random processes and Sequences. Power Spectrum of Complex Processes.					
Module:5	Linear Systems with Random Inputs	5 hours			
Linear system Fundamentals-Linear systems with continuous-Time and discrete-Time random inputs. Random Signal Response of Linear Systems-Product Device response to a Random Signal-Spectral Characteristic of System Response. Response of quadratic, half wave, full-wave, and sigmoid detectors to Gaussian signals.					
Module:6	Noise and Modelling of Noise Sources	6 hours			
Noise Definitions- White noise and colored noise. System Evaluation using Random noise					

Spectral Characteristic of System Response for Noise-Noise Bandwidth – Bandpass – Band limited – Narrow Band Processes. Resistive Noise Sources – Arbitrary Noise Sources – Effective Noise Sources-Noise Temperature-Noise Figure-Incremental Modelling of Noisy Networks- Modelling of Practical Noisy Networks.			
Module:7	Optimum Linear Systems		5 hours
Signal to Noise Ratio – Mean Square Error- Optimization by Parameter Selection- Matched Filter for Colored Noise- Matched Filter for White Noise-Practical Applications.			
Module:8	Contemporary Issues		2 hours
	Total Lecture hours:		45 hours
Text Book(s)			
1.	P.Z. Peebles, Probability, Random Variables, and Random Signal Principles, 2017, 4 th edition, McGraw Hill, New Delhi, India.		
Reference Books			
1.	Papoulis and S.U. Pillai, Probability, Random variables and stochastic processes, 2017, 4 th edition, McGraw Hill, New Delhi, India.		
2.	Hwei Hsu, Probability, Random variables, Random Processes, 2017, Schaum's outline series, McGraw Hill, New Delhi, India.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		28-07-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
BECE206P	Analog Circuits Lab	0	0	2	1
Pre-requisite	BECE201L	Syllabus version			
		1.0			
Course Objective					
To apply knowledge gained in the theory course and get hands-on experience of the topics.					
Course Outcome					
At the end of the course the student will be able to					
1. Design and analyse the frequency response of amplifiers and differential amplifiers. 2. Determine the efficiency of different classes of power amplifiers. 3. Design and analyse the waveform generator circuits.					
Indicative Experiments					
1.	Design of single-stage and multistage amplifiers using BJT and to analyse its frequency response characteristics.	4 hours			
2.	Design of single-stage and multistage amplifiers using MOSFET and to analyse its frequency response characteristics.	4 hours			
3.	Design of a Power Amplifier and estimation of its power conversion efficiency	2 hours			
4.	Design of differential amplifier using MOSFET and determine its CMRR and also perform the frequency response analysis.	4 hours			
5.	Design of closed-loop amplifiers using Op-amp and perform experimentation to determine voltage gain.	2 hours			
6.	Design of circuits using op-amp to determine the DC and AC characteristics.	4 hours			
7.	Design of Instrumentation amplifier for the given specifications.	2 hours			
8.	Design of Comparator and Schmitt trigger circuits using Op-amp.	4 hours			
9.	Design of waveform generators and filters using op-amp	2 hours			
10.	Design of circuits using IC 555 timer for different applications.	2 hours			
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE206L	Analog Circuits	3	0	0	3
Pre-requisite	BECE201L	Syllabus version			
		1.0			
Course Objectives					
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Module:5	Comparators and Waveform Generators	6 hours
Comparator and its applications - Schmitt trigger - Free-running, One-shot Multivibrators - Barkhausen Criterion - Sinewave generators - Phase-shift and Wein-bridge oscillators - Square, Triangular and Saw-tooth wave function generators.		
Module:6	Active filters and Data Converters	6 hours
Filter classifications: First and second order Low-pass and High pass filter designs, Band-pass filter, Notch filter. Sample-and-hold circuits, DAC characteristics, D/A conversion techniques, A/D characteristics, A/D conversion techniques.		
Module:7	Special Function ICs	5 hours
IC 555 timer, Astable and Monostable operations, and applications. IC voltage regulator - LM317.		
Module:8	Contemporary issues	2 hours
Total Lecture		45 hours
Textbook(s)		
1.	Adel S. Sedra, Kenneth C. Smith and Arun N. Chandorkar, Microelectronic Circuits: Theory and Applications, 2014, 7 th Edition, Oxford University Press, New York.	
Reference Books		
1.	J. D. Roy Choudhury, Linear Integrated Circuits, 2018, 5 th Edition, New-Age International Publishers, New Delhi.	
2.	Donald A Neamen, Microelectronics: Circuit Analysis and Design, 2010, 4 th Edition, Mc Graw-Hill.	
3.	P. Malvino, D. J. Bates, Electronic Principles, 2017, 7 th Edition, Tata Mc Graw-Hill.	
4.	R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 2015, 11 th Edition, Pearson Education.	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		
Recommended by Board of Studies		14-05-2022
Approved by Academic Council		No. 66
Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE205L	Engineering Electromagnetics	3	0	0	3
Pre-requisite	BPHY101L, BPHY101P	Syllabus version			
		1.0			
Course Objectives					
1. Introduce the basic concepts and properties of Electrostatics & Magnetostatics. 2. Study the propagation of EM wave through time varying Maxwell's equations and to analyze the EM Wave propagation in different conducting and dielectric media. 3. Familiarize the concept of transmission and reflection in various transmission lines and to design different transmission lines and matching circuits using Smith chart.					
Course Outcome					
At the end of the course, the student will be able to 1. Evaluate and analyse Electric Fields & Electric Potential due to different Charge distributions. 2. Compute and analyze magnetic fields in different materials and media. 3. Analyze the EM wave propagation in conducting as well as in dielectric materials through time varying Maxwell's equations. 4. Illustrate the wave mechanism in different transmission lines at high frequencies using transmission line parameters. 5. Design Impedance matching circuits using Smith chart. 6. Analyze the field components of different waveguides based on various modes of E and H field.					
Module:1	Vector Calculus	3 hours			
Cartesian, Cylindrical, and Spherical coordinate systems. Divergence, Gradient and Curl.					
Module:2	Electrostatics	8 hours			
Coulomb's Law, Electric Fields due to Different Charge Distributions, Gauss Law and Applications, Electrostatic Potential, Potential Gradient, Equipotential surfaces, Electric Dipole, Polarization in Dielectrics, Boundary conditions, current density, continuity equation. Laplace and Poisson's equation, Capacitance, Method of Images.					
Module:3	Magnetostatics	7 hours			
Biot-Savart's Law, Ampere's Circuit Law and Applications, Magnetic Flux Density, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Magnetic Dipole, Magnetization in materials, Boundary conditions, Inductances and Magnetic Energy.					
Module:4	Time Varying Fields	5 hours			
Faraday's Law and Lenz law, Maxwell's Equations in Integral and differential form, Wave equation, Uniform plane wave propagation in lossy dielectrics, Lossless Dielectrics, Good Conductors and free space. Polarization, Power and Poynting Vector.					
Module:5	Transmission Lines	8 hours			
Types, Parameters, Transmission Line Equations, Primary & Secondary Constants, Expressions for Characteristic Impedance, Propagation Constant, Phase velocity, input impedance, Reflection Coefficient, VSWR. Characterization of lossless, low loss and distortionless transmission lines. Significance of short circuit and open circuit lines of length $\lambda/8$, $\lambda/4$ and $\lambda/2$. Coaxial line, Planar transmission lines –Types, Microstrip Lines: field distribution, design equations, Q factor, losses in microstrip lines.					
Module:6	Smith Chart & Matching Circuits	7 hours			
Smith Chart configuration and applications: Input impedance, admittance, VSWR, Reflection					

Coefficient, return loss, standing wave pattern. Matching Circuit Design- Quarter wave, Impedance Transformer, Single Stub, Double Stub and Lumped element matching.			
Module:7		Waveguides	5 hours
TEM, TE and TM waves, Parallel plate waveguide, Rectangular waveguide, Characteristics of wave guide- guide wavelength, cut off wave length, cut off frequency, wave impedance, phase constant, phase velocity, group velocity. Circular waveguide and Cavity resonator (Qualitative study)			
Module:8		Contemporary issues	2 hours
	Total Lecture hours:		45 hours
Text Book(s)			
1.	William Hayt and John Buck, Engineering Electromagnetics, 2017, 8 th Edition, Tata McGraw Hill, New Delhi, India.		
Reference Books			
1.	Mathew O Sadiku, Elements of Electromagnetics, Oxford University press, New York, USA.		
2.	E.C. Jordan and K.G. Balmain, Electromagnetic Waves and Radiating Systems, , PEI, India		
3.	D. M. Pozar, Microwave engineering, 2013, 4 th Edition, Wiley & Sons, USA.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
BECE204P	Microprocessors and Microcontrollers Lab	0	0	2	1
Pre-requisite	BECE102L	Syllabus version			
		1.0			
Course Objectives					
1. To familiarize the students with assembly language programming using microprocessor and microcontroller.					
2. To familiarize the students with Embedded C language programming using microcontroller.					
3. To interface peripherals and I/O devices with the microcontroller and microprocessor.					
Course Outcome					
Student will be able to					
1. Showcase the skill, knowledge and ability of programming microcontroller and microprocessor using its instruction set.					
2. Expertise with microcontroller and interfaces including general purpose input/ output, timers, serial communication, LCD, keypad and ADC.					
Indicative Experiments [Experiments using 8086/8051/ARM]					
1	Assembly language programming of Arithmetic/logical operations.				6 hours
2	Assembly language programming of memory operations.				4 hours
3	Assembly language programming/ Embedded C programming for interfacing the peripherals: General purpose input/ output, timers, serial communication, LCD, keypad and ADC.				10 hours
4	Hardware implementation of peripheral interfacing: General purpose input/ output, timers, serial communication, LCD, keypad and ADC.				10 hours
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE204L	Microprocessors and Microcontrollers	3	0	0	3
Pre-requisite	BECE102L	Syllabus version			
		1.0			
Course Objectives:					
1. To acquaint students with architectures of Intel microprocessors, microcontroller and ARM processors. 2. To familiarize the students with assembly language programming in 8051 microcontroller and ARM processor. 3. To interface peripherals and I/O devices with the 8051 microcontroller.					
Course Outcome:					
At the end of the course, the student should be able to 1. Comprehend the various microprocessors including Intel Pentium Processors 2. Infer the architecture and Programming of Intel 8086 Microprocessor. 3. Comprehend the architectures and programming of 8051 microcontroller. 4. Deploy the implementation of various peripherals such as general purpose input/output, timers, serial communication, LCD, keypad and ADC with 8051 microcontroller 5. Infer the architecture of ARM Processor 6. Develop the simple application using ARM processor.					
Module:1	Overview of Microprocessors	3 hours			
Introduction to Microprocessors, 8-bit/16-bit Microprocessor, Overview of Intel Pentium, I (i3, i5, i7) Series Processor.					
Module:2	Microprocessor Architecture and Interfacing: Intel x86	8 hours			
16-bit Microprocessor: 8086 - Architecture and Addressing modes, Memory Segmentation, Instruction Set, Assembly Language Processing, Programming with DOS and BIOS function calls, minimum and maximum mode configuration, Programmable Peripheral Interface (8255), Programmable Timer Controller (8254), Memory Interface to 8086.					
Module:3	Microcontroller Architecture: Intel 8051	7 hours			
Microcontroller 8051 - Organization and Architecture, RAM-ROM Organization, Machine Cycle, Instruction set: Addressing modes, Data Processing - Stack, Arithmetic, Logical; Branching – Unconditional and Conditional, Assembly programming.					
Module:4	Microcontroller 8051 Peripherals	5 hours			
I/O Ports, Timers-Counters, Serial Communication and Interrupts.					
Module:5	I/O interfacing with Microcontroller 8051	7 hours			
LCD, LED, Keypad, Analog-to-Digital Convertors, Digital-to-Analog Convertors, Sensor with Signal Conditioning Interface.					
Module:6	ARM Processor Architecture	5 hours			
ARM Design Philosophy; Overview of ARM architecture; States [ARM, Thumb, Jazelle]; Registers, Modes; Conditional Execution; Pipelining; Vector Tables; Exception handling.					
Module:7	ARM Instruction Set	8 hours			
ARM Instruction- data processing instructions, branch instructions, load store instructions, SWI Instruction, Loading instructions, conditional Execution, Assembly Programming.					
Module:8	Contemporary issues	2 hours			

		Total Lecture hours:		45 hours	
Text Book(s)					
1.	A.K. Ray, K.M. Bhurchandi, Advanced Microprocessor and Peripherals, 2012, 2 nd Edition, Tata McGraw-Hill, India.				
2.	Mohammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems, 2014, 2 nd Edition, Pearson, India.				
Reference Books					
1.	Muhammad Ali Mazidi, ARM Assembly Language Programming & Architecture: 1, 2016, 2nd Edition, Microdigitaled.com				
2.	A. Nagoor Kani, 8086 Microprocessors and its Applications, 2017, Second Edition, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, India.				
3.	Joseph Yiu, The Definitive Guide to ARM® Cortex®-M0 and Cortex-M0+ Processors, 2015, 2 nd Edition, Elsevier Science & Technology, UK				
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test					
Recommended by Board of Studies			14-05-2022		
Approved by Academic Council			No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BECE102P	Digital Systems Design Lab	0	0	2	1
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objective					
To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.					
Course Outcome					
At the end of the course the student will be able to					
- Design, simulate and synthesize combinational logic circuits, data path circuits and sequential logic circuits using Verilog HDL. - Design and implement FSM on FPGA. - Design and implement small digital systems on FPGA.					
Indicative Experiments					
1.	Characteristics of Digital ICs, Realization of Boolean expressions	2 hours			
2.	Design and Verilog modeling of Combinational Logic circuits	4 hours			
3.	Design and Verilog modeling of various data path elements - Adders	2 hours			
4.	Design and Verilog modeling of various data path elements - Multipliers	2 hours			
5.	Implementation of combinational circuits – (FPGA / Trainer Kit)	2 hours			
6.	Implementation of data path circuit - (FPGA / Trainer Kit)	2 hours			
7.	Design and Verilog modeling of simple sequential circuits like Counters and Shift registers	2 hours			
8.	Design and Verilog modeling of complex sequential circuits	2 hours			
9.	Implementation of Sequential circuits - (FPGA / Trainer Kit)	2 hours			
10.	Design and Verilog modeling of FSM based design – Serial Adder	2 hours			
11.	Design and Verilog modeling of FSM based design – Traffic Light Controller / Vending Machine	4 hours			
12.	Design of ALU	4 hours			
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment and Final Assessment Test					
Recommended by Board of Studies		14-05-2022			
Approved by Academic Council		No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BECE102L	Digital Systems Design	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objectives					
1. Provide an understanding of Boolean algebra and logic functions. 2. Develop the knowledge of combinational and sequential logic circuit design. 3. Design and model the data path circuits for digital systems. 4. Establish a strong understanding of programmable logic. 5. Enable the student to design and model the logic circuits using Verilog HDL.					
Course Outcome					
At the end of the course the student will be able to 1. Optimize the logic functions using and Boolean principles and K-map. 2. Model the Combinational and Sequential logic circuits using Verilog HDL. 3. Design the various combinational logic circuits and data path circuits. 4. Analyze and apply the design aspects of sequential logic circuits. 5. Analyze and apply the design aspects of Finite state machines. 6. Examine the basic architectures of programmable logic devices.					
Module:1	Digital Logic	8 hours			
Boolean Algebra: Basic definitions, Axiomatic definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms, Simplification of Boolean functions. Gate-Level Minimization: The Map Method (K-map up to 4 variable), Product of Sums and Sum of Products Simplification, NAND and NOR Implementation. Logic Families: Digital Logic Gates, TTL and CMOS logic families.					
Module:2	Verilog HDL	5 hours			
Lexical Conventions, Ports and Modules, Operators, Dataflow Modelling, Gate Level Modelling, Behavioural Modeling, Test Bench.					
Module:3	Design of Combinational Logic Circuits	8 hours			
Design Procedure, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Decoders, Encoders, Multiplexers, De-multiplexers, Parity generator and checker, Applications of Decoder, Multiplexer and De-multiplexer. Modeling of Combinational logic circuits using Verilog HDL.					
Module:4	Design of data path circuits	6 hours			
N-bit Parallel Adder/Subtractor, Carry Look Ahead Adder, Unsigned Array Multiplier, Booth Multiplier, 4-Bit Magnitude comparator. Modeling of data path circuits using Verilog HDL.					
Module:5	Design of Sequential Logic Circuits	8 hours			
Latches, Flip-Flops - SR, D, JK & T, Buffer Registers, Shift Registers - SISO, SIPO, PISO, PIPO, Design of synchronous sequential circuits: state table and state diagrams, Design of counters: Modulo-n, Johnson, Ring, Up/Down, Asynchronous counter. Modeling of sequential logic circuits using Verilog HDL.					
Module:6	Design of FSM	4 hours			
Finite state Machine(FSM):Mealy FSM and Moore FSM , Design Example : Sequence detection, Modeling of FSM using Verilog HDL.					
Module:7	Programmable Logic Devices	4 hours			
Types of Programmable Logic Devices: PLA, PAL, CPLD, FPGA Generic Architecture.					

Module:8		Contemporary issues	
		2 hours	

BECE203L	Circuit Theory			L	T	P	C
				3	1	0	4
Pre-requisite	BEEE101L, BEEE101P			Syllabus version			
				1.0			
Course Objectives							
1. To prepare the students to analyse the given electrical network using phasors and graph theory. 2. To introduce the students with the basic knowledge of Laplace transform, Fourier Transform and Fourier series and to analyse the network using suitable technique. 3. To prepare the students to analyse the two-port networks, passive filters, and attenuators.							
Course Outcome							
1. Apply the knowledge of various circuit analysis techniques such as mesh analysis, nodal analysis, and network theorems to investigate the given network. 2. Analyse the resonance and transient response of the first order, second order circuits 3. Able to solve the networks using graphical approach. 4. Design and analyse two-port networks, passive filters and attenuators. 5. Able to analyse the given network by transforming from time domain to S domain. 6. Analyse the given network using Fourier series and transforming from time domain to frequency domain.							
Module:1	Sinusoidal Steady-State Analysis			10 hours			
Review of steady state sinusoidal analysis using phasors. Node voltage and Mesh current analysis, special cases. Network theorems: Superposition, Thevenin, Norton and maximum power transfer theorems.							
Module:2	Transient Response of first order, second order circuits and Resonance			10 hours			
Time response in inductance (L) and capacitance (C), steady state response of circuits with RLC components. Response (forced & natural) of first order circuits (RL & RC): series, parallel, source free, complex circuits with more than one resistance, power sources and switches. Response of second order circuit (RLC): series, parallel and complex circuits. Series and parallel resonance condition.							
Module:3	Network Graphs			6 hours			
Definition of terms. Matrices associated with graphs: incidence, reduced incidence, fundamental cut-set and fundamental tie-set.							
Module:4	Two-Port Networks			8 hours			
Significance and applications of one port and two port networks. Two port network analysis using Admittance (Y) parameters, Impedance (Z) parameters and Hybrid (h) parameters. Interconnection of Two port networks							
Module:5	Filters, Attenuators and equalizers			8 hours			
Concept of filtering. Filter types: Low-pass, High-pass, Band-pass and Band-stop and their characteristics. Design of attenuators: T, π , Lattice and Bridged-T types, Equalizers.							
Module:6	Circuit Analysis in the S domain			8 hours			
Introduction to Laplace transform (LT), poles, zeros and transfer functions. Analysis of first and second order circuits subjected to periodic and aperiodic excitations using Laplace transforms.							
Module:7	Application of Fourier series and Fourier transforms in Circuit Analysis			8 hours			
Trigonometric Fourier series, Symmetry conditions, Applications in circuit solving, Fourier transforms. Properties, Applications in circuit solving, Comparisons of Fourier and Laplace transforms.							

Module:8	Contemporary Issues	2 hours		
	Total Lecture hours:		60 hours	
Text Book(s)				
1.	Charles K. Alexander, Matthew N. O. Sadiku, “Fundamentals of Electric Circuits,” 2020, Seventh Edition, McGraw Hill Higher Education.			
Reference Books				
1.	W.H.Hayt, J.E.Kemmerly & S.M.Durbin, “Engineering Circuit Analysis”, 2019, Ninth Edition, McGraw Hill Higher Education.			
2.	Allan R. Hambley, “Electrical Engineering – Principles & applications”, 2016, Sixth Edition, Pearson Education, Noida, India.			
Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)				
Recommended by Board of Studies		09-11-2021		
Approved by Academic Council		No. 64	Date	16-12-2021

BECE202L	Signals and Systems	L	T	P	C
		2	1	0	3
Pre-requisite	BMAT102L	Syllabus version			
		1.0			
Course Objectives					
1. To understand the basic attributes of signals and systems. 2. To analyse the signals and systems in time and transformed domains such as Fourier, Laplace and Z- transform. 3. To understand the concept of sampling process.					
Course Outcome					
On studying this course, students will be able to 1. Differentiate between various types of signals and understand the implication of operations on signals. 2. Understand the terms like causal, dynamic, linear, time invariant and stability of systems. Also, students will be able to compute impulse response of both continuous time and discrete time systems. 3. Perform the transformation of CT and DT signals from time domain to frequency domain and understand the concept of distribution of energy as a function of frequency. 4. Convert the CT signals to DT signals and vice versa and understand their consequences. 5. Processing of bandpass signals through bandpass systems. 6. Solve differential and difference equations, with initial conditions, using Laplace and Z transforms respectively.					
Module:1	Continuous Time and Discrete Time signals	7 hours			
Signal classification – Types of signals: Unit impulse, unit step, ramp, sign, and exponential signals – Operations on signals – Analogy between vectors and signals –Concept of linearly dependent and independent vectors, Orthogonality – Mean square error – Computation of energy, power, periodicity, Norms and moments of signals, – Distance metrics for signals.					
Module:2	Continuous Time and Discrete Time systems	7 hours			
Classification of systems – Linearity, time invariance, stability, Invertibility, Causality and memory systems. Interconnection of systems. Systems defined by differential & difference equations- Impulse and step response of the systems. Transmission of signals through LTI systems - Convolution and Correlation for CT and DT systems					
Module:3	Fourier Series	5 hours			
The response of LTI systems to complex exponentials, Fourier series representation of Continuous Time Periodic Signals, Gibb's phenomena, Properties of CTFS, Fourier series representation of Discrete Time Periodic Signals, Properties of DTFS, Power spectral density.					
Module:4	Fourier Transforms	6 hours			
Representation of aperiodic continuous signals: The Continuous Time Fourier Transform, The Fourier Transform for Periodic Signals, Properties of CTFT, Systems characterized by linear constant-coefficient Differential Equations. Representation of aperiodic discrete signals: The Discrete Time Fourier Transform, The Fourier Transform for Periodic Signals, Properties of DTFT, DTFT of systems characterized by linear constant-coefficient Difference Equations. Energy spectral density.					
Module:5	Hilbert Transform and processing of Band Pass signals	6 hours			
Magnitude and phase response of the systems. Group delay, Representation of bandpass					

signals: In-phase and quadrature phase components, Hilbert transform – Pre and complex envelopes. Processing of bandpass signals through bandpass systems.			
Module:6	Sampling		4 hours
Impulse train sampling -Zero order hold, Nyquist criteria – Aliasing - Reconstruction – Ideal filtering			
Module:7	Laplace and Z-Transform		8 hours
Laplace transform: Definition – ROC – Properties – S-plane causality and BIBO stability – Transfer function – Unilateral Laplace transform: Solution of differential equations with initial conditions. Z-transform: Definition - S-plane to Z-plane mapping - ROC – Properties of Z-transform. System analysis – Transfer function - Causality- BIBO stability – Unilateral Z-transform, Solution of. Difference equations with initial conditions.			
Module:8	Contemporary Issues		2 hours
Total Lecture hours:			45 hours
Text Book(s)			
1.	Alan V.Oppenheim, Alan S.Willsky, with S.Hamid Nawab, "Signals and Systems", Prentice-Hall of India.2 nd Edition,2016.		
2.	M.J.Roberts, Govind Sharma, "Fundamentals of Signals and Systems", 2 nd Edition, Tata McGraw-Hill,2017.		
Reference Books			
1.	Simon Haykin, Barry Van Veen, “Signals and Systems”, 2 nd edition, Wiley Publications, 2021.		
2.	P. Rama Krishna Rao and Shankar Prakriya, “Signals and Systems”, second edition - Mc-Graw Hill, 2017.		
3	Simon Haykin, “Communication systems”, 4 th edition, Wiley Publications.		
4	Lathi BP, “Signals, Systems and Communications”, 2 nd Edition, BS Publications 2019.		
Mode of assessment: Continuous assessment / FAT / Assignments, Oral examination and others			
Recommended by Board of Studies		09-11-2021	
Approved by Academic Council		No. 64	Date 16-12-2021

BECE201L	Electronic Materials and Devices	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objectives					
1. To introduce the students with concepts of electronic materials and their properties 2. To demystify semiconductor device physics and electronics. 3. To equip the students with the tools for solving problems of semiconductor devices and circuits. 4. To familiarize the students with various electronic devices and their circuit applications.					
Course Outcome					
Students will be able to:					
1. Comprehend the basics of electronic materials, crystal structure, electrical and thermal conduction in solids. 2. Draw and analyze the band diagrams of semiconductor devices. 3. Understand and model the carrier transport mechanisms in semiconductors. 4. Design and model the PN- junctions for given specifications. 5. Develop small signal models for BJT and also design BJT amplifiers under different Configurations. 6. Model MOS capacitors, MOSFETs; learn and mitigate the short channel effects and design future technology nodes.					
Module:1	Electrical and Thermal conduction in Solids	6 hours			
Crystalline state – Crystalline defects – Single Crystal Growth -Czochralski Growth – Amorphous Semiconductor - Classical Theory: Drude Model – Temperature dependence of resistivity – The Hall Effect and Hall Devices – Thermal conduction – Electrical conductivity of non-metals – Skin Effect – Thin metal films.					
Module:2	Semiconductor Fundamentals	7 hours			
Introduction to Solids, Crystals, and Electronic materials – Formation of energy bands – Energy band Model – Effective mass - Direct and indirect bandgap – Elemental and compound semiconductors, Intrinsic and extrinsic semiconductors. The density of states, Carrier statistics, Fermi level, Equilibrium carrier concentration, Quasi-equilibrium, and Quasi-Fermi level.					
Module:3	Carrier Transport Mechanism	6 hours			
Charge carriers in semiconductors – Drift and Diffusion of carriers – Mobility – Generation, Recombination and injection of carriers – Carrier transport equations – Excess carrier lifetime.					
Module:4	Junction diodes	8 hours			
PN Junction – Equilibrium and biased – Contact potential and space charge phenomena, Current – Voltage relationship, Diode capacitances, One-sided PN junction, Avalanche and Zener breakdown, Zener diode, small-signal model of PN junction. Metal-Semiconductor Contact: Schottky diode, current-voltage characteristics, Ohmic contacts. Varactor diode, Tunnel diode, Photo Diode, Solar Cells.					
Module:5	Bipolar Junction Transistor	5 hours			
Device structure and physical operation, Current – Voltage relationship – CB, CE, and CC configuration – Nonideal effects – Base width modulation – Ebers-Moll model. Small signal models, Device capacitances – Equivalent circuit model.					
Module:6	Field Effect Transistor	7 hours			
JFET, MOS Capacitors: Energy-band diagrams, flat-band, accumulation, depletion, inversion, threshold voltage, Capacitance-Voltage characteristics. MOSFETs: Current-Voltage characteristics, velocity saturation, leakage currents, short channel effects – V_t roll-off and drain-induced barrier lowering, scaling limits, alternative technologies. Equivalent circuit model-second order effects.					

Module:7	Other Electronic Materials	4 hours
Dielectrics, Insulators, Ferroelectric Materials, Supercapacitors, Graphene, Carbon Nanotubes, Superconductors		
Module:8	Contemporary Topics	2 hours
Guest lecture from industry and R & D organizations		
	Total Lecture hours:	45 hours
Text Book(s)		
1.	S.O.Kasap, Principles of Electronic Materials and Devices , 2018, 4 th Edition, McGraw Hill Education.	
Reference Books		
1.	Simon Sze, Ming-Kwei Lee, Semiconductor Devices, Physics and Technology,2012, 3 rd Edition, Wiley International Student Version.	
2.	Ben G Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 2015, 7 th Edition, Pearson.	
3.	Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, Microelectronic Circuits: Theory and Applications,2014, 7 th Edition, Oxford University Press, New York.	
4.	Donald A. Neamen, Semiconductor Physics and Devices, 2017,4th Edition, McGraw Hill.	
Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar / group discussion / fieldwork (include only those that are relevant to the course. Use ‘,’ to separate the evaluations. Eg. CAT, Quiz and FAT.		
Recommended by Board of Studies		09-11-2021
Approved by Academic Council		No. 64 Date 16-12-2021

BPHY101P	Engineering Physics Lab	L	T	P	C
		0	0	2	1
Pre-requisite	12th or equivalent	Syllabus version			
		1.0			
Course Objectives					
To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.					
Course Outcome					
At the end of the course the student will be able to					
1. Comprehend the dual nature of radiation and matter by means of experiments.					
2. Get hands-on experience on the topics of quantum mechanical ideas in the laboratory.					
3. Apply low power lasers in optics and optical fiber related experiments.					
Indicative Experiments					
1.	To determine the dependence of fundamental frequency with the length and tension of a stretched string using sonometer.				
2.	To determine the characteristics of EM waves using Hertz experiment				
3.	To determine the wavelength of laser source (He-Ne laser and diode lasers of different wavelengths) using diffraction grating				
4.	To demonstrate the wave nature of electron by diffraction through graphite sheet				
5.	To determine the Planck's constant using electroluminescence process				
6.	To numerically demonstrate the discrete energy levels and the wavefunctions using Schrödinger equation (e.g., particle in a box problem can be given as an assignment)				
7.	To determine the refractive index of a prism using spectrometer (angle of prism will be given)				
8.	To determine the efficiency of a solar cell				
9.	To determine the acceptance angle and numerical aperture of an optical fiber				
10.	To demonstrate the phase velocity and group velocity (simulation)				
Total Laboratory Hours					30 hours
Mode of assessment: Continuous assessment / FAT / Oral examination					
Recommended by Board of Studies			26.06.2021		
Approved by Academic Council			No. 63	Date	23.09.2021

Course Code	Course Title	L	T	P	C
BPHY101L	Engineering Physics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To explain the dual nature of radiation and matter.					
2. To apply Schrödinger's equation to solve finite and infinite potential problems and apply quantum ideas at the nanoscale.					
3. To understand the Maxwell's equations for electromagnetic waves and apply the concepts to semiconductors for engineering applications.					
Course Outcome					
At the end of the course the student will be able to					
1. Comprehend the phenomenon of waves and electromagnetic waves.					
2. Understand the principles of quantum mechanics.					
3. Apply quantum mechanical ideas to subatomic domain.					
4. Appreciate the fundamental principles of a laser and its types.					
5. Design a typical optical fiber communication system using optoelectronic devices.					
Module:1	Introduction to waves	7 hours			
Waves on a string - Wave equation on a string (derivation) - Harmonic waves- reflection and transmission of waves at a boundary (Qualitative) - Standing waves and their eigenfrequencies.					
Module:2	Electromagnetic waves	7 hours			
Physics of divergence - gradient and curl - Qualitative understanding of surface and volume integral - Maxwell Equations (Qualitative) - Displacement current - Electromagnetic wave equation in free space - Plane electromagnetic waves in free space - Hertz's experiment.					
Module:3	Elements of quantum mechanics	6 hours			
Need for Quantum Mechanics: Idea of Quantization (Planck and Einstein) - Compton effect (Qualitative) – de Broglie hypothesis - - Davisson-Germer experiment - Wave function and probability interpretation - Heisenberg uncertainty principle - Schrödinger wave equation (time dependent and time independent).					
Module:4	Applications of quantum mechanics	5 hours			
Eigenvalues and eigenfunction of particle confined in one dimensional box - Basics of nanophysics - Quantum confinement and nanostructures - Tunnel effect (qualitative) and scanning tunneling microscope.					
Module:5	Lasers	6 hours			
Laser characteristics - spatial and temporal coherence - Einstein coefficients and their significance - Population inversion - two, three and four level systems - Pumping schemes - threshold gain coefficient - Components of a laser - He-Ne, Nd:YAG and CO2 lasers and their engineering applications.					
Module:6	Propagation of EM waves in optical fibers	6 hours			
Introduction to optical fiber communication system - light propagation through fibers - Acceptance angle - Numerical aperture - V-parameter - Types of fibers – Attenuation - Dispersion-intermodal and intramodal. Application of fiber in medicine - Endoscopy.					
Module:7	Optoelectronic devices	6 hours			
Introduction to semiconductors - direct and indirect bandgap – Sources: LED and laser diode, Photodetectors: PN and PIN.					
Module:8	Contemporary issues	2 hours			
Total Lecture hours:					
45 hours					

Textbook(s)			
1.	H. D. Young and R. A. Freedman, University Physics with Modern Physics, 2020, 15 th Edition, Pearson, USA.		
2.	D. K. Mynbaev and Lowell L. Scheiner, Fiber Optic Communication Technology, 2011, 1 st Edition, Pearson, USA		
Reference Books			
1.	H. J. Pain, The Physics of vibrations and waves, 2013, 6 th Edition, Wiley Publications, India.		
2.	R. A. Serway, J. W. Jewett, Jr, Physics for Scientists and Engineers with Modern Physics, 2019, 10 th Edition, Cengage Learning, USA.		
3.	K. Krane, Modern Physics, 2020, 4 th Edition, Wiley Edition, India.		
4.	M.N.O. Sadiku, Principles of Electromagnetics, 2015, 6 th Edition, Oxford University Press, India.		
5.	W. Silfvast, Laser Fundamentals, 2012, 2 nd Edition, Cambridge University Press, India.		
Mode of Evaluation: Written assignment, Quiz, CAT and FAT			
Recommended by Board of Studies		26-06-2021	
Approved by Academic Council		No. 63	Date 23-09-2021

BMAT202P	Probability and Statistics Lab	L	T	P	C
		0	0	2	1
Pre-requisite	BMAT101L, BMAT101P	Syllabus version			
		1.0			
Course Objectives:					
1. To enable the students for having experimental knowledge of basic concepts of statistics using R programming.					
2. To study the relationship of real-time data and decision making through testing methods using R.					
3. To make students capable to do experimental research using statistics in various engineering problems.					
Course Outcomes:					
At the end of the course the student should be able to:					
1. Demonstrate R programming for statistical data.					
2. Carry out appropriate analysis of statistical methods through experimental techniques using R.					
Indicative Experiments					
1.	Introduction: Understanding Data types; importing/exporting data	Total Laboratory hours: 30			
2.	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations				
3.	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination				
4.	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficients of determination				
5.	Fitting the probability distributions: Binomial distribution				
6.	Normal distribution, Poisson distribution				
7.	Testing of hypothesis for one sample mean and proportion from real time problems				
8.	Testing of hypothesis for two sample means and proportion from real time problems				
9.	Applying the t-test for independent and dependent samples				
10.	Applying Chi-square test for goodness of fit test and Contingency test to real dataset				
11.	Performing ANOVA for real dataset for Completely randomized design, Randomized Block design, Latin square Design				
Text Book					
1. Statistical analysis with R by Joseph Schmuller, John Wiley and sons Inc., New Jersey 2017.					
Reference Books:					
1. The Book of R: A First course in Programming and Statistics, by Tilman M Davies, William Pollock, 2016.					
2. R for Data Science, by Hadley Wickham and Garrett Grolemund, O' Reilly Media Inc., 2017.					
Mode of assessment: Continuous assessment, FAT / Oral examination and others					
Recommended by Board of Studies		24-06-2021			
Approved by Academic Council		No. 64	Date	16-12-2021	

BMAT202L	Probability and Statistics	L	T	P	C
		3	0	0	3
Pre-requisite	BMAT101L, BMAT101P	Syllabus version			
		1.0			
Course Objectives :					
1. To provide students with a framework that will help them choose the appropriate descriptive methods in various data analysis situations. 2. To analyze distributions and relationship of real-time data. 3. To apply estimation and testing methods to make inference and modelling techniques for decision making.					
Course Outcome :					
At the end of the course the student should be able to:					
1. Compute and interpret descriptive statistics using numerical and graphical techniques. 2. Understand the basic concepts of random variables and find an appropriate distribution for analyzing data specific to an experiment. 3. Apply statistical methods like correlation, regression analysis in analyzing, interpreting experimental data. 4. Make appropriate decisions using statistical inference that is the central to experimental research. 5. Use statistical methodology and tools in reliability engineering problems.					
Module:1	Introduction to Statistics	6 hours			
Statistics and data analysis; Measures of central tendency; Measure of Dispersion, Moments-Skewness-Kurtosis (Concepts only).					
Module:2	Random variables	8 hours			
Random variables- Probability mass function, distribution and density functions-Joint probability distribution and Joint density functions; Marginal, Conditional distribution and Density functions- Mathematical expectation and its properties- Covariance, Moment generating function.					
Module:3	Correlation and Regression	4 hours			
Correlation and Regression – Rank Correlation; Partial and Multiple correlation; Multiple regression.					
Module:4	Probability Distributions	7 hours			
Binomial distribution; Poisson distributions; Normal distribution; Gamma distribution; Exponential distribution; Weibull distribution.					
Module:5	Hypothesis Testing-I	4 hours			
Testing of hypothesis –Types of errors - Critical region, Procedure for testing of hypothesis-Large sample tests- Z test for Single Proportion- Difference of Proportion- Mean and difference of means.					
Module:6	Hypothesis Testing-II	9 hours			
Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance – One way-Two way-Three way classifications - CRD-RBD- LSD.					
Module:7	Reliability	5 hours			
Basic concepts- Hazard function-Reliabilities of series and parallel systems- System					

Reliability - Maintainability-Preventive and repair maintenance- Availability.			
Module:8	Contemporary Issues		2 hours
	Total lecture hours:		45 hours
Text Book:			
1. R. E. Walpole, R. H. Myers, S. L. Mayers, K. Ye, Probability and Statistics for engineers and scientists, 2012, 9 th Edition, Pearson Education.			
Reference Books			
1. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, 2016, 6 th Edition, John Wiley & Sons.			
2. E. Balagurusamy, Reliability Engineering, 2017, Tata McGraw Hill, Tenth reprint.			
3. J. L. Devore, Probability and Statistics, 2012, 8 th Edition, Brooks/Cole, Cengage Learning.			
4. R. A. Johnson, Miller Freund's, Probability and Statistics for Engineers, 2011, 8th edition, Prentice Hall India.			
5. Bilal M. Ayyub, Richard H. McCuen, Probability, Statistics and Reliability for Engineers and Scientists, 2011, 3 rd edition, CRC press.			
Mode of Evaluation: Digital Assignments, Continuous Assessment Tests, Quiz, Final Assessment Test.			
Recommended by Board of Studies		24-06-2021	
Approved by Academic Council		No. 64	Date 16-12-2021

BMAT201L	Complex Variables and Linear Algebra	L	T	P	C
		3	1	0	4
Pre-requisite	BMAT102L	Syllabus version			
		1.0			
Course Objectives					
1. To present comprehensive, compact, and integrated treatment of one of the most important branches of applied mathematics namely Complex variables to the engineers and the scientists. 2. To present comprehensive, compact, and integrated treatment of another most important branches of applied mathematics namely Linear Algebra to the engineers and the scientists. 3. To provide students with a framework of the concepts that will help them to analyse deeply about many complex problems.					
Course Outcomes					
At the end of the course the student should be able to					
1. Construct analytic functions and find complex potential of fluid flow and electric fields. 2. Find the image of straight lines by elementary transformations and to express analytic functions in power series. 3. Evaluate real integrals using techniques of contour integration. 4. Use the power of inner product and norm for analysis. 5. Use matrices and transformations for solving engineering problems.					
Module:1	Analytic Functions	7hours			
Complex variable - Analytic functions and Cauchy – Riemann equations; Laplace equation and Harmonic functions; Construction of Harmonic conjugate and analytic functions; Applications of analytic functions to fluid-flow and electric field problems.					
Module:2	Conformal and Bilinear transformations	7 hours			
Conformal mapping - Elementary transformations; Translation, Magnification, Rotation, Inversion; Exponential and Square transformations ($w = e^z, z^2$); Bilinear transformation; Cross-ratio-Images of the regions bounded by straight lines under the above transformations;					
Module:3	Complex Integration	7 hours			
Functions given by Power Series - Taylor and Laurent series-Singularities - Poles – Residues; Integration of a complex function along a contour; Statements of Cauchy-Goursat theorem- Cauchy's integral formula-Cauchy's residue theorem-Evaluation of real integrals-Indented contour integral.					
Module:4	Vector Spaces	6 hours			
Vector space – subspace; linear combination - span - linearly dependent – Independent – bases; Dimensions; Finite dimensional vector space. Row and column spaces; Rank and nullity.					
Module:5	Linear Transformations	6 hours			
Linear transformations – Basic properties; Invertible linear transformation; Matrices of linear transformations; Vector space of linear transformations; Change of bases; Similarity.					
Module:6	Inner Product Spaces	5 hours			
Dot products and inner products; Lengths and angles of vectors; Matrix representations of inner products; Gram - Schmidt – Orthogonalization.					
Module:7	Matrices and System of Equations	5 hours			
Eigenvalues and Eigen vectors; Properties of Eigenvalues and Eigen vectors; Cayley-Hamilton theorem; System of linear equations; Gaussian elimination and Gauss Jordan methods.					
Module:8	Contemporary issues:	2 hours			

		Total Lecture hours:	45 hours
		Total Tutorial hours :	15 hours
Text Book(s)			
1. G. Dennis Zill, Patrick D. Shanahan, A first course in complex analysis with applications, 2013, 3rd Edition, Jones and Bartlett Publishers Series in Mathematics. 2. Jin Ho Kwak, Sungpyo Hong, Linear Algebra, 2004, Second edition, Springer.			
Reference Books			
1. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10 th Edition, John Wiley & Sons (Wiley student Edition). 2. Michael, D. Greenberg, Advanced Engineering Mathematics, 2006, 2 nd Edition, Pearson Education. 3. Bernard Kolman, David, R. Hill, Introductory Linear Algebra - An applied first course, 2011, 9th Edition Pearson Education. 4. Gilbert Strang, Introduction to Linear Algebra, 2015, 5 th Edition, Cengage Learning 5. B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers.			
Mode of Evaluation: Digital Assignments(Solutions by using soft skill), Quiz, Continuous Assessments, Final Assessment Test.			
Recommended by Board of Studies		24-06-2021	
Approved by Academic Council		No. 64	Date 16-12-2021

BMAT102L	Differential Equations and Transforms	L	T	P	C
		3	1	0	4
Pre-requisite	BMAT101L, BMAT101P	Syllabus version			
		1.0			
Course Objectives					
<					

convolution method. Difference equation - first and second order difference equations with constant coefficients - solution of simple difference equations using Z-transform.			
Module:8	Contemporary Issues		2 hours
	Total Lecture hours:		45 hours
	Total Tutorial hours :		15 hours
Text Book(s)			
1. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, John Wiley India.			
2. B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers.			
Reference Books			
1. Michael D. Greenberg, Advanced Engineering Mathematics, 2006, 2nd Edition, Pearson Education, Indian edition.			
2. A First Course in Differential Equations with Modelling Applications, Dennis Zill, 2018, 11th Edition, Cengage Publishers.			
Mode of Evaluation: CAT, written assignment, Quiz, FAT			
Recommended by Board of Studies		24-06-2021	
Approved by Academic Council		No. 64	Date 16-12-2021

BMAT101P	Calculus Lab		L	T	P	C
			0	0	2	1
Pre-requisite	NIL	Syllabus version				
		1.0				
Course Objectives						
1. To familiarize with the basic syntax, semantics and library functions of MATLAB which serves as a tool not only in calculus but also many courses in engineering and sciences						
2. To visualize mathematical functions and its related properties.						
3. To evaluate single and multiple integrals and understand it graphically.						
Course Outcomes						
At the end of the course the student should be able to:						
1. Demonstrate MATLAB code for challenging problems in engineering						
2. Using plots/displays, interpret and illustrate elementary mathematical functions and procedures.						
Indicative Experiments						
1.	Introduction to MATLAB through matrices and general Syntax					
2.	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB					
3.	Evaluating Extremum of a single variable function					
4.	Understanding integration as Area under the curve					
5.	Evaluation of Volume by Integrals (Solids of Revolution)					
6.	Evaluating maxima and minima of functions of two variables					
7.	Applying Lagrange multiplier optimization method					
8.	Evaluating Volume under surfaces					
9.	Evaluating triple integrals					
10.	Evaluating gradient, curl and divergence					
11.	Evaluating line integrals in vectors					
12.	Applying Green's theorem to real world problems					
			Total Laboratory Hours		30 hours	
Text Book						
1.	Brian H. Hahn, Daniel T. Valentine, Essential MATLAB for Engineers and Scientists, Academic Press, 7th edition, 2019.					
Reference Books						
1.	Amos Gilat, MATLAB: An Introduction with Applications, Wiley, 6/e, 2016.					
2	Maritn Brokate, Pammy Manchanda, Abul Hasan Siddiqi, Calculus for Scientists and Engineers, Springer, 2019					
Mode of assessment: DA and FAT						
Recommended by Board of Studies			24.06.2021			
Approved by Academic Council			No. 63	Date	23.09.2021	

BMAT101L	Calculus	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objectives					
1. To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.					
2. To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.					
3. Enhance to use technology to model the physical situations into mathematical problems, experiment, interpret results, and verify conclusions.					
Course Outcomes					
At the end of the course the student should be able to:					
1. Apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions					
2. Evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints					
3. Evaluate multiple integrals in Cartesian, Polar, Cylindrical and Spherical coordinates.					
4. Use special functions to evaluate various types of integrals.					
5. Understand gradient, directional derivatives, divergence, curl, Green's, Stokes and Gauss Divergence theorems.					
Module:1	Single Variable Calculus	8 hours			
Differentiation- Extrema on an Interval Rolle's Theorem and the Mean value theorem-Increasing and decreasing functions.-First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution.					
Module:2	Multivariable Calculus	5 hours			
Functions of two variables-limits and continuity-partial derivatives –total differential-Jacobian and its properties.					
Module:3	Application of Multivariable Calculus	5 hours			
Taylor's expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange's multiplier method.					
Module:4	Multiple integrals	8 hours			
Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates - evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates.					
Module:5	Special Functions	6 hours			
Beta and Gamma functions–interrelation between beta and gamma functions-evaluation of multiple integrals using gamma and beta functions. Dirichlet's integral -Error functions complementary error functions.					
Module:6	Vector Differentiation	5 hours			
Scalar and vector valued functions – gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials. Statement of vector identities-simple problems.					
Module:7	Vector Integration	6 hours			
Line, surface and volume integrals - Statement of Green's, Stoke's and Gauss divergence theorems -verification and evaluation of vector integrals using them.					
Module:8	Contemporary Topics	2 hours			
Guest lectures from Industry and, Research and Development Organizations					
	Total Lecture hours:	45 hours			
Text Book					
1.	George B.Thomas, D.Weir and J. Hass, Thomas Calculus, 2014, 13th edition, Pearson				

Reference Books			
1.	Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, Wiley India		
2.	B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers		
3.	John Bird, Higher Engineering Mathematics, 2017, 6th Edition, Elsevier Limited.		
4.	James Stewart, Calculus: Early Transcendental, 2017, 8th edition, Cengage Learning.		
5.	K.A.Stroud and Dexter J. Booth, Engineering Mathematics, 2013, 7th Edition, Palgrave Macmillan.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies		24.06.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

BENG102P		Technical Report Writing				L	T	P	C
						0	0	2	1
Pre-requisite	Technical English Communication					Syllabus version			
					1.0				
Course Objectives:									
1. To augment specific writing skills for preparing technical reports									
2. To think critically, evaluate, analyse general and complex technical information									
3. To acquire proficiency in writing and presenting reports									
Course Outcomes:									
1. Write error free sentences using appropriate grammar, vocabulary and style									
2. Synthesize information and concepts in preparing reports									
3. Demonstrate the ability to write and present reports on diverse topics									
Indicative Experiments									
1.	Advanced Grammar, Vocabulary and Editing Usage of Tenses - Adjectives and Adverbs - Jargon vs Technical Vocabulary – Abbreviations - Mechanics of Editing: Punctuation and Proof Reading Activity: Worksheets								
2.	Research and Analyses Synchronise Technical Details from Newspapers - Magazines - Articles and e-content Activity: Writing introduction and literature review								
3.	Systematisation of Information Techniques to Converge Objective-Oriented data in Diverse Technical Reports Activity: Preparing Questionnaire								
4.	Data Visualisation Interpreting Data - Graphs - Tables – Charts - Imagery - Infographics Activity: Transcoding								
5.	Introduction to Reports Meaning - Definition - Purpose - Characteristics and Types of Reports Activity: Worksheets on Types of reports								
6.	Structure of Reports Title – Preface – Acknowledgement - Abstract/Summary – Introduction - Materials and Methods – Results – Discussion - Conclusion - Suggestions/Recommendations Activity: Identifying the structure of report								
7.	Report Writing Data Collection - Draft an Outline and Organize Information Activity: Drafting reports								
8.	Supplementary Texts Appendix – Index – Glossary – References – Bibliography - Notes Activity: Organizing supplementary texts								
9.	Review of Final Reports Structure – Content – Style - Layout and Referencing Activity: Examining clarity and coherence in final reports								
10.	Presentation Presenting Technical Reports Activity: Planning, creating and digital presentation of reports								
Total Laboratory Hours								30 hours	
Mode of assessment: Continuous Assessment / FAT / Assignments / Quiz / Presentations / Oral examination									
Recommended by Board of Studies					28.06.2021				
Approved by Academic Council					No. 63	Date	23.09.2021		

BENG101P	Technical English Communication Lab	L	T	P	C
		0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
1. To use appropriate grammatical structures in professional communication					
2. To improve English communication skills for better employability					
3.To enhance meaningful communication skills in writing and public speaking					
Course Outcomes:					
1.Demonstrate professional rhetoric and articulate ideas effectively					
2. Interpret material on technology and deliver eloquent presentations					
3. Apply receptive and productive skills in real life situations and develop workplace communication					
Indicative Experiments					
1.	Grammar & Vocabulary Error Detection Activity: -Worksheets				
2.	Listening to Narratives Interviews of eminent personalities & Ted Talks Activity: Listening Comprehension / Summarising				
3.	Video Resume SWOT Analysis & digital resume techniques Activity: Preparing a digital résumé for mock interview				
4.	Product & Process Description Describing and Sequencing Activity: Demonstration of product and process				
5.	Mock Meetings Types of meetings and meeting etiquette Activity: Conduct of meetings and drafting minutes of the meeting				
6.	Reading research article Scientific and Technical articles Activity: Writing Literature review				
7.	Analytical Reading Case Studies on Communication, Team Building and Leadership Activity: Group Discussion				
8.	Presentations Preparing Conference/Seminar paper Activity: Individual/ Group presentations				
9.	Intensive Listening Scientific documentaries Activity: Note taking and Summarising				
10.	Interview Skills Interview questions and techniques Activity: Mock Interviews				
Total Laboratory Hours					30 hours
Mode of Assessment: Continuous Assessment / FAT / Written Assignments / Quiz/ Oral Presentation and Group Activity.					
Recommended by Board of Studies		28.06.2021			
Approved by Academic Council		No. 63	Date	23.09.2021	

BENG101L	Technical English Communication	L	T	P	C
		2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
1. To develop LSRW skills for effective communication in professional situations					
2. To enhance knowledge of grammar and vocabulary for meaningful communication					
3. To understand information from diverse texts for effective technical communication					
Course Outcomes:					
1. Use grammar and vocabulary appropriately while writing and speaking					
2. Apply the concepts of communication skills in formal and informal situations					
3. Demonstrate effective reading and listening skills to synthesize and draw intelligent inferences					
4. Write clearly and significantly in academic and general contexts					
Module:1	Introduction to Communication	4 hours			
Nature and Process - Types of communication: Intra-personal, Interpersonal, Group-verbal and non-verbal communication / Cross-cultural Communication - Communication Barriers and Essentials of good communication - Principles of Effective Communications					
Module:2	Grammatical Aspects	4 hours			
Sentence Pattern - Modal Verbs - Concord (SVA) - Conditionals - Error detection					
Module:3	Written Correspondence	4 hours			
Job Application Letters - Resume Writing - Statement of Purpose					
Module:4	Business Correspondence	4 hours			
Business Letters: Calling for Quotation, Complaint & Sales Letter – Memo - Minutes of Meeting - Describing products and processes					
Module:5	Professional Writing	4 hours			
Paraphrasing & Summarizing - Executive Summary - Structure and Types of Proposal – Recommendations					
Module:6	Team Building & Leadership Skills	4 hours			
Principles of Leadership - Team Leadership Model - Negotiation Skills - Conflict Management					
Module:7	Research Writing	4 hours			
Interpreting and Analysing a research article - Approaches to Review Paper Writing - Structure of a research article - Referencing					
Module:8	Guest Lecture from Industry and R&D organizations	2 hours			
Contemporary Issues					
Total Lecture hours:					30 hours
Text Book(s)					
1.	Raman, Meenakshi & Sangeeta Sharma. (2015). <i>Technical Communication: Principles and Practice</i> , (3 rd Edition). India: Oxford University Press.				
Reference Books					
1.	Taylor, Shirley & Chandra .V. (2010). <i>Communication for Business A Practical Approach</i> 4 th Edition. India: Pearson Longman.				
2.	Kumar, Sanjay & Pushpalatha. (2018). <i>English Language and Communication Skills for Engineers</i> . India: Oxford University Press.				
3.	Koneru Aruna. (2020). <i>English Language Skills for Engineers</i> . India: McGraw Hill Education.				
4.	Rizvi, M. Ashraf. (2018). <i>Effective Technical Communication</i> 2 nd Edition. Chennai: McGraw Hill Education.				
5.	Mishra, Sunitha & Muralikrishna,C. (2014). <i>Communication Skills for Engineers</i> . India: Pearson Education.				

6.	Watkins, P. (2018). <i>Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers</i> . India: Cambridge University Press.		
Mode of Evaluation : CAT / Assignment / Quiz / FAT / Group Discussion			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

Course code	Course Title	L	T	P	C
BEEE102P	Basic Electrical and Electronics Engineering Lab	0	0	2	1
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objective					
1. Design and solve the fundamental electrical and electronics circuits					
Course Outcomes					
1. Identify appropriate method of solving the fundamental electrical and electronics circuits					
2. Design and conduct experiments on electrical and electronics circuits					
Experiments (Indicative)					
1	Verification of Kirchoff's law				
2	Verification of Maximum Power Transfer Theorem				
3	Staircase wiring circuit layout for multi storage building				
4	Lamp dimmer circuit (Darlington pair circuit using transistors) used in cars.				
5	Measurement of Earth resistance using Megger				
6	Sinusoidal steady state response of RLC circuits				
7	Three phase power measurement for ac loads				
8	Design of half-adder and full-adder digital circuits				
9	Synthesis of 8x1 multiplexer and 1x8 de-multiplexers				
10	Characteristics of PN diode and acts as switch				
11	Realization of single-phase rectifier				
12	Design of regulated power supply using Zener diode.				
13	Characteristics of MOSFET				
14	Characteristics of BJT				
15	Measurement of energy using single-phase energy meter				
16	Measurement of power in a 1-phase circuit by using CTs and PTs				
Total Laboratory Hours					30 hours
Mode of assessment: Continuous assessment, FAT					
Recommended by Board of Studies			28-05-2022		
Approved by Academic Council			No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
BEEE102L	Basic Electrical and Electronics Engineering	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. Familiarize with various laws and theorems to solve electric and electronic circuits					
2. Provide an overview on working principle of machines					
3. Excel the concepts of semiconductor devices, op-amps and digital circuits					
Course Outcomes					
On completion of the course, the students will be able to:					
1. Evaluate DC and AC circuit parameters using various laws and theorems					
2. Comprehend the parameters of magnetic circuits					
3. Classify and compare various types of electrical machines and its applications					
4. Design basic combinational circuits in digital system					
5. Analyze the characteristics and applications of semiconductor devices					
Module:1	DC Circuits	7 hours			
Basic circuit elements and sources; Ohms law; Kirchhoff's laws; Series and Parallel connection of circuit elements; Star-delta transformation; Mesh current analysis; Node voltage analysis; Theorems: Thevenin's, Maximum power transfer and Superposition theorem.					
Module:2	AC Circuits	8 hours			
Alternating voltages and currents, RMS, average, maximum values, Single Phase RL, RC, RLC series circuits, Power in AC circuits, Power Factor, Three phase balanced systems, Star and delta Connections, Electrical Safety, Fuses and Earthing.					
Module:3	Magnetic Circuits	7 hours			
Magnetic field; Toroidal core: Flux density, Flux linkage; Magnetic circuit with airgap; Reluctance in series and parallel circuits; Self and mutual inductance; Transformer: turn ratio determination.					
Module:4	Electrical Machines	7 hours			
Construction, working principle and applications of DC Machines, Transformers, Three phase Induction motors, synchronous generators, single phase induction motors, special machines stepper motor, universal motor and BLDC motor.					
Module:5	Digital Systems	7 hours			
Binary arithmetic; Number base conversion; Boolean algebra: simplification of Boolean functions using K-maps; Logic gates; Design of basic combinational circuits: adders, multiplexers, de-multiplexers.					
Module:6	Semiconductor Devices and Applications	7 hours			
Characteristics: PN junction diode, Zener diode, BJT, MOSFET; Applications: Rectifier, Voltage regulator, Operational amplifier.					
Module:7	Contemporary Issues	2 hours			
Total Lecture hours:					
45 hours					
Text Books					
1	Allan R. Hambley, "Electrical Engineering -Principles & Applications", 2019, 6 th Edition, Pearson Education				
2	V. D. Toro, Electrical Engineering Fundamentals, 2 nd edition. PHI, 2014				
Reference Books					
1	R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 11 th edition.				

	Pearson, 2012		
2	DP Kothari & Nagrath, "Basic Electric Engineering", 2019, Tata McGraw Hill		
Recommended by Board of Studies		28-05-2022	
Approved by Academic Council		No. 67	Date 08-08-2022

BCHY101P	Engineering Chemistry Lab	L	T	P	C
		0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objective					
To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.					
Course Outcome :					
At the end of the course the student will be able to					
1. Understand the importance and hands-on experience on analysis of metal ions by means of experiments.					
2. Get practical experience on synthesis and characterization of the organic molecules and nanomaterials in the laboratory.					
3. Apply their knowledge in thermodynamic functions, kinetics and molecular geometries through the experiments.					
Indicative Experiments					
1.	Thermodynamics functions from EMF measurements : Zinc – Copper system				
2.	Determination of reaction rate, order and molecularity of ethylacetate hydrolysis				
3.	Colorimetric estimation of Ni ²⁺ using conventional and smart phone digital-imaging methods				
4.	Laboratory scale preparation of important drug intermediate - para aminophenol for the synthesis for acetaminophen				
5.	Magnesium-sea water activated cell – Effect of salt concentration on voltage generation				
6.	Analysis of iron in an alloy sample by potentiometry				
7.	Preparation of tin oxide by sol- gel method and its characterization				
8.	Size dependent colour variation of Cu ₂ O nanoparticles by spectrophotometer				
9.	Determination of hardness of water sample by complexometric titration before and after ion-exchange process				
10.	Computational Optimization of molecular geometry using Avogadro software				
Total Laboratory Hours				30 hours	
Mode of assessment: Mode of assessment: Continuous assessment / FAT / Oral examination and others					
Recommended by Board of Studies		28.06.2021			
Approved by Academic Council		No. 63	Date	23.09.2021	

BCHY101L	Engineering Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. To enable students to have fundamental understanding of the basic concepts of different disciplines of chemistry. 2. To provide avenues for learning advanced concepts from school to university 3. To empower students with emerging concepts in applied chemistry to be useful in addressing societal needs 4. To integrate analytical and computational ability with experimental skills to create individuals competent in basic science and its by-product of its application. 5. To offer opportunities to create pathways for self-reliant in terms of knowledge and higher learning					
Course Outcomes :					
1. Understand the fundamental concepts in organic, inorganic, physical, and analytical chemistry. 2. Analyze the principles of applied chemistry in solving the societal issues. 3. Apply chemical concepts for the advancement of materials. 4. Appreciate the fundamental principles of spectroscopy and the related applications. 5. Design new materials, energy conversion devices and new protective coating techniques.					
Module:1	Chemical thermodynamics and kinetics	6 hours			
Laws of thermodynamics - entropy change (selected processes) – spontaneity of a chemical reaction and Gibbs free energy - heat transfer; Kinetics - Concept of activation energy and energy barrier - Arrhenius equation- effect of catalysts (homo and heterogeneous) – Enzyme catalysis (Michaelis-Menten Mechanism).					
Module:2	Metal complexes and organometallics	6 hours			
Inorganic complexes - structure, bonding and application; Organometallics – introduction, stability, structure and applications of metal carbonyls, ferrocene and Grignard reagent; Metals in biology (haemoglobin, chlorophyll- structure and property).					
Module:3	Organic intermediates and reaction transformations	6 hours			
Organic intermediates - stability and structure of carbocations, carbanions and radicals; Aromatics (aromaticity) and heterocycles (3, 4, 5, 6 membered and fused systems); Organic transformations for making useful drugs for specific disease targets (two examples) and dyes (addition, elimination, substitution and cross coupling reactions).					
Module:4	Energy devices	6 hours			
Electrochemical and electrolytic cells – electrode materials with examples (semi-conductors), electrode-electrolyte interface- chemistry of Li ion secondary batteries, supercapacitors; Fuel cells: H ₂ -O ₂ and solid oxide fuel cell (SOFC); Solar cells - photovoltaic cell (silicon based), photoelectrochemical cells and dye-sensitized cells.					
Module:5	Functional materials	7 hours			
Oxides of AB, AB ₂ , ABO ₃ type (specific examples); Composites - types and properties; Polymers - thermosetting and thermoplastic polymers – synthesis and application (TEFLON, BAKELITE); Conducting polymers- polyacetylene and effect of doping – chemistry of display devices specific to OLEDs; Nano materials – introduction, bulk vs nano (quantum dots), top-down and bottom-up approaches for synthesis, and properties of nano Au.					
Module:6	Spectroscopic, diffraction and microscopic techniques	5 hours			
Fundamental concepts in spectroscopic and instrumental techniques; Principle and applications of UV-Visible and XRD techniques (numericals); Overview of various techniques such as AAS, IR, NMR, SEM and TEM.					
Module:7	Industrial applications	7 hours			

Water purification methods - zeolites, ion-exchange resins and reverse osmosis; Fuels and combustion -LCV, HCV, Bomb calorimeter (numericals), anti-knocking agents); Protective coatings for corrosion control: cathodic and anodic protection - PVD technique; Chemical sensors for environmental monitoring - gas sensors; Overview of computational methodologies: energy minimization and conformational analysis.			
Module:8	Contemporary topics		2 hours
Guest lectures from Industry and, Research and Development Organizations			
	Total Lecture hours:		45 hours
Textbook			
1.	Theodore E. Brown, H Eugene, LeMay Bruce E. Bursten, Catherine Murphy, Patrick Woodward, Matthew E. Stoltzfus, Chemistry: The Central Science, 2017, 14th edition, Pearson Publishers, 2017. UK		
Reference Books			
1.	Peter Vollhardt, Neil Schore, Organic Chemistry: Structure and Function, 2018, 8th ed WH Freeman, London		
2.	Atkins' Physical Chemistry: International, 2018, Eleventh edition, Oxford University Press; UK		
3.	Colin Banwell, Elaine McCash, Fundamentals for Molecular Spectroscopy, 4th Edition, McGraw Hill, US		
4.	Solid State Chemistry and its Applications, Anthony R. West. 2014, 2nd edition, Wiley, UK.		
5.	Angèle Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Photovoltaic solar energy: From fundamentals to Applications, 2017, Wiley publishers, UK.		
6.	Lawrence S. Brown and Thomas Holme, Chemistry for engineering students, 2018, 4 th edition – <i>Open access version</i>		
Mode of Evaluation: CAT, Written assignment, Quiz and FAT			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

BCLE212L	NATURAL DISASTER MITIGATION AND MANAGEMENT	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
The objectives of this course is to :					
1. Provide adequate knowledge about disaster mitigation, preparedness, response, and recovery to face disaster among government bodies, institutions, NGO's, etc.					
2. Obtain the knowledge different disaster and its preparedness and mitigation methods.					
3. Provide adequate knowledge about applications of space technology in disaster monitoring and information dissemination.					
Course Outcomes					
Upon completion of this course, the student will be able to :					
1. Understand the safety precautions and how to handle the disasters.					
2. Develop skills in different disasters and its mitigation methods.					
3. Examine how quickly to response and prepared for different disasters.					
4. Understand how the space and communication technology used in disaster monitoring and early warning.					
5. Learn the current affairs on disaster management and resilience to disasters.					
Module: 1	Introduction to Disasters				7 hours
Natural Disasters Principles, Elements, Important Community needs-Hyogo Framework for Action (HFA)–Sendai Framework for Disaster Risk Reduction-Disaster Management System-Hazard, Vulnerability and Risk–History of Disaster Management in India-Disaster Management Act-Disaster Management Structure in India-Nodal Agencies for Disaster Management in India-Disaster Types.					
Module: 2	Water and Climate Related Disasters				6 hours
Floods, Cyclones-Tornadoes and Hurricanes, Hailstorm, Cloud Burst, Heat Wave and Cold Wave, Snow Avalanches, Droughts, Famine, Sea Erosion, Thunder and Lighting – Definition, Cause, Types, Safety Precautions.					
Module: 3	Geology Related Disasters				5 hours
Landslides and Mudflows, Earthquakes, Dam Failures / Dam Bursts, Mine Fires, Tsunami–Definition, Cause, Types, Safety Precautions.					
Module: 4	Chemical, Nuclear and Biological Related Disasters				5 hours
Chemical and Industrial Disasters, Nuclear Disasters, Biological Disaster and Epidemics Pest Attacks, Cattle Epidemics, Food Poisoning-Definition, Cause, Types, Safety Precautions.					
Module: 5	Accident Related Disasters				6 hours
Forest Fires, Urban Fires, Mine Flooding, Oil Spill, Major Building Collapse, Serial Bomb Blasts, Festival Disasters and Fires, Electrical Disasters and Fires, Air, Road and Rail Accidents, Boat Capsizing, Village Fire-Definition, Cause, Types, Safety Precautions.					
Module: 6	Mapping and Monitoring				7 hours
Modelling, risk analysis and loss estimation–Natural disaster risk Reduction Strategies-Prevention and mitigation-Applications of Space Technology (Satellite Communications, GPS, GIS and Remote Sensing and Information / Communication Technologies (ICT) in Early warning Systems-Disaster Monitoring and Support Centre–Information Dissemination–Mobile Communications-Social Media etc through case studies.					
Module: 7	Community Based Disaster Risk Reduction				7 hours
Psychological effects after disasters-Socio Psycho care-Managing stress–Education and Training–Establishment of capacity building among various stake holders–Government, Educational institutions, Civil Society–Use of Multi-media knowledge products for self-education.					

Module: 8		Contemporary Issues		2 hours	
Total Lecture Hours				45 hours	
Text Book(s)					
1	Bhandari, R.K, Disaster Education and Management, A Joyride for Students, Teachers and Disaster Managers, 2014, Springer, India.				
2	Ranke, Ulrich, Natural Disaster Risk Management-Geosciences and Social Responsibility, 2016, First Edition, Springer International Publishing.				
Reference Books					
1	Brian Tomaszewski, Geographic Information Systems (GIS) for Disaster Management, 2014, CRC Press, UK.				
2	Harsh K. Gupta, Disaster Management, 2006, Second Edition, Indian National Science Academy.				
3	Dhawan, Disaster Management and Preparedness, 2012, First Edition, CBS Publisher Pvt. Ltd.				
Mode of Evaluation: CAT, Assignment, Quiz, FAT.					
Recommended by Board of Studies			24.02.2022		
Approved by Academic Council			No. 65	Date	17-03-2022

Course code	Course Title	L	T	P	C
BBMD206L	Biomechanics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
1. Introduce the basic concepts of solid mechanics and fluid dynamics with respect to physiological systems. 2. Familiarize students with the mathematical models that can be used in the analysis of physiological systems. 3. Understand the parameters and constraints pertaining to the designing of the physiological tissues and organs.					
Course Outcome					
1. To interpret the basic concepts of mechanics and fluid dynamics in human body. 2. To realize the effect of abnormal posture, its influences on gait and role of ergonomics. 3. To develop better acquaintance about various bio fluids. 4. To model any solid/ fluid tissue and their interactions. 5. To explore various parameters and constraints in FEM and FEA of solid and fluid bio structures.					
Module:1	Biomechanics of joint structure and function	9 hours			
Kinematics and Kinetics – Descriptions of Motion – Forces – Statics and Dynamics – Translatory Motion in Linear and Concurrent Force Systems – Additional Linear Force Considerations – Torque or Moment of Force – Muscle Forces – Lever Systems or Classes of Levers – Joint Structure and Function – Joint Design – Materials Used in Human Joints – General Properties of Connective Tissue – Complexities of Human Joint Design – Joint Function – General Changes with Disease – Injury – Immobilization – Exercise – Overuse.					
Module:2	Muscle Structure and Function	5 hours			
Elements of Muscle Structure – Muscle Function – Effects of Immobilization – Injury – Aging					
Module:3	Integrated Function and Ergonomics	8 hours			
Posture – Static and Dynamic Postures – Kinetics and Kinematics of Posture – Optimal Posture – Analysis of Standing Posture – Sitting Postures – Lying Postures – Effects of Age – Pregnancy – Occupation and Recreation on Posture – Gait – Kinematics and Kinetics – Stair and Running Gaits – Effects of Age – Gender – Assistive Devices and Orthoses – Abnormal Gait – Ergonomics.					
Module:4	Constitutive Equation	7 hours			
Stress – Strain – Strain Rate – Constitutive Equations – NonViscous Fluid – Newtonian Viscous Fluid – Hookean Elastic Solid – Effect of Temperature – Materials with More Complex Mechanical Behavior – Viscoelasticity – Use of Viscoelastic Models – Response of a Viscoelastic Body to Harmonic Excitation – Methods of Testing.					
Module:5	Flow Properties of Blood	5 hours			
Blood Rheology: An Outline – Laminar Flow of Blood in a Tube – Fluid-Mechanical Interaction of Red Blood Cells – Thrombus Formation and Dissolution – Medical Applications of Blood Rheology.					
Module:6	Bioviscoelastic Fluids	3 hours			
Newton's ring – Methods of Testing and Data Presentation – Protoplasm – Mucus from the Respiratory Tract – Cervical Mucus and Semen – Saliva – Synovial Fluid.					
Module:7	Mechanical Remodeling of Tissues	6 hours			
Active Remodeling of Blood vessel – Skeletal muscle: Hill's Three-Element Model – Heart Muscle – Smooth Muscles: Ureter – Bone and Cartilage – modeling using software – concepts of Finite Element Modeling and Finite Element Analysis.					
Module:8	Contemporary Issues	2 hours			

	Total Lecture hours:		45 hours
Text Book(s)			
1.	Pamela K Levangie and Cynthia C Norkins, Joint Structure and Function: A Comprehensive Analysis, 2019, 6th Edition, F. A. Davis Company, USA.		
2.	Y C Fung, Biomechanics – Mechanical Properties of Living Tissue, 2016, 2nd Edition, Spinger, USA.		
Reference Books			
1.	R S Bridger, Introduction to Human Factors and Ergonomics, 2018, 4th Edition, CRS Press Taylor and Francis Group, USA.		
2.	Singiresu S Rao, The Finite Element Method in Engineering, 2019, 6th Edition, Elsevier, USA.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies		14-05-2022	
Approved by Academic Council		No. 66	Date 16-06-2022